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PLASTICS TECHNOLOGY

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DECEMBER 1956
VOLUME II, NUMBER 12

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Cover photo: A Halvorson Christmas Tree.

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Letters to the Editor

Plight of Small Businesses

Dear Sir:

The myriads of Mr. Nalle-type customers (*see guest editorial in October issue, page 657*) should stop griping about the normal hazards of business in a competitive economy and direct their attentions to the real dangers and insist that their "giant" suppliers act as their spokesmen in doing something about it.

We make vinyl plastisol. Our last shipment of resin powder was billed 2¢ per pound under quotation. The last shipment of plasticizer was billed at 2¢ per pound above quotation. Annual average price changes are of minimum concern compared to the alarming increased cost of doing business.

We have just had to renew our eight-year lease at a 38% increase. The landlord had charts and tables to prove that the average annual rate of inflation was 4½%. He said we should pass all such inflation on to the customer.

In 1956 our labor, packaging costs, equipment costs, and taxes went up 5-10%. Experience tells us that we cannot pass along these costs—we've hit the ceiling. Many of our customers, mostly small manufacturers, are already at the "non-profit" stage. Some have quit to take jobs with the "giants."

Since the "giants" cannot exist without thousands of small customers who depend on profits and incentives to remain in business, it is their obligation to act as customer spokesmen to influence politicians and voters of the need for not only a "stable" dollar, but also a "valuable" dollar.

Part of this sound economy crusade can be financed from normal advertising funds. Big companies no longer have to brag constantly about the quality and value of their goods and services. They still have a duty to promote a healthy economy and, thus, make their own future more secure.

Their customers have an equal duty to preach and act at the local level on the fallacy of "benevolent socialism" by any name. Be ready to prove that to make the wage-earner's dollar more valuable and make the invested dollar earn interest at more than the annual inflation rate, many presently popular share-the-wealth concepts must be repudiated and discarded.

Inflation has reached its bearable peak. The plight of the unorganized wage-earner and most small businessmen is desperate. We must try to avoid a general "buyers' strike," such as happened in 1922.

Frank Pray
Technicraft Co.
Boston, Mass.

• • •

Wants Jewelry Boxes

Dear Sir:

Can you suggest one or more sources for fancy jewelry boxes and allied ladies items?

Vern Baker
V. Edward Baker,
Elyria, Ohio

(Suggestions are invited for transmittal to Mr. Baker.—Editor)

• • •

Plastic-to-Glass Bond

Dear Sir:

We would like to contact a source, preferably local, that makes a liquid plastic which can be applied to glass and will form a permanent bond. The purpose of this plastic would be to prevent glass from shattering upon impact.

Economy of price is of primary consideration. Application should be by spray or, preferably, by brush, and the plastic should air-dry at room temperature.

J. S. Ross, Sec'y-Treas.,
National Shower Door Co.
Los Angeles, Calif.

(All replies will be transmitted to Mr. Ross.—Editor)

• • •

Copy of Abstracted Article

Dear Sir:

We are interested in receiving a copy of an article entitled "PTFE and PTFCE," by J. Gadsby, *Rubber & Plastics Age*, 37, 3, 177 (March 1956), appearing under Abstracts of Important

rticles, page 618, in your September 956 issue.

Since we do not have the address of hat publication, we would greatly ap-reciate any assistance given us which ill help obtain this article.

For your convenience, we are en-losing a copy of this letter which you ight want to forward to *Rubber & lastics Age.*

F. M. Hall, Sales Manager
of Thermoplastics Div.,
Cordo Chemical Corp.
Norwalk, Conn.

(This letter has been forwarded to the British publication. Since we are unable to furnish copies of abstracted articles, a complete listing of the publishers and addresses of magazines from which we abstract is printed quarterly in our magazine. Any reader desiring a complete copy of an abstracted article should write directly to the publisher of the magazine in which that article appeared. —Editor)

• • •

Plastic Model Kits

Dear Sir:

Our firm imports merchandise which is sold in the hobby trade. At this time, we are interested in obtaining foreign sources of supply of plastic model kits; i.e., model planes, boats, and ships.

We are particularly interested in doing business with Great Britain and European countries, and would appreciate the names of any firms you may know of in these areas.

F. H. Janson, Jr.
American Rattan & Reed Mfg. Co.
Brooklyn, New York

(Our information in this field is quite scanty. We are printing this letter to invite replies from our readers.—Editor)

• • •

We invite letters from our readers for publication in these columns. Such letters may be of comment or criticism, requests for information, or of general interest. The only requirement is that all letters must be fully identified as to name of sender, company affiliation, and address.

A letter will not be printed if publication is not desired by the sender.

Letters requesting information on technical or engineering problems will be printed to elicit replies by the readers, either directly or through these columns. Upon request the identities of such "problem" letters will not be divulged.

—The Editor

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ADVASTAB T-10
ADVASTAB T-18
ADVASTAB T-17M
ADVASTAB T-671
ADVASTAB T-50LT
ADVASTAB T-72

If you are interested in quality vinyls, you owe it to your product; you owe it to your customers to use *Advance* ORGANO-TIN's. Why not try them soon? Samples and complete data are available. When writing, it would help us to make more intelligent recommendations if you described in a general way your stabilization problem.

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NEW BRUNSWICK, N. J.

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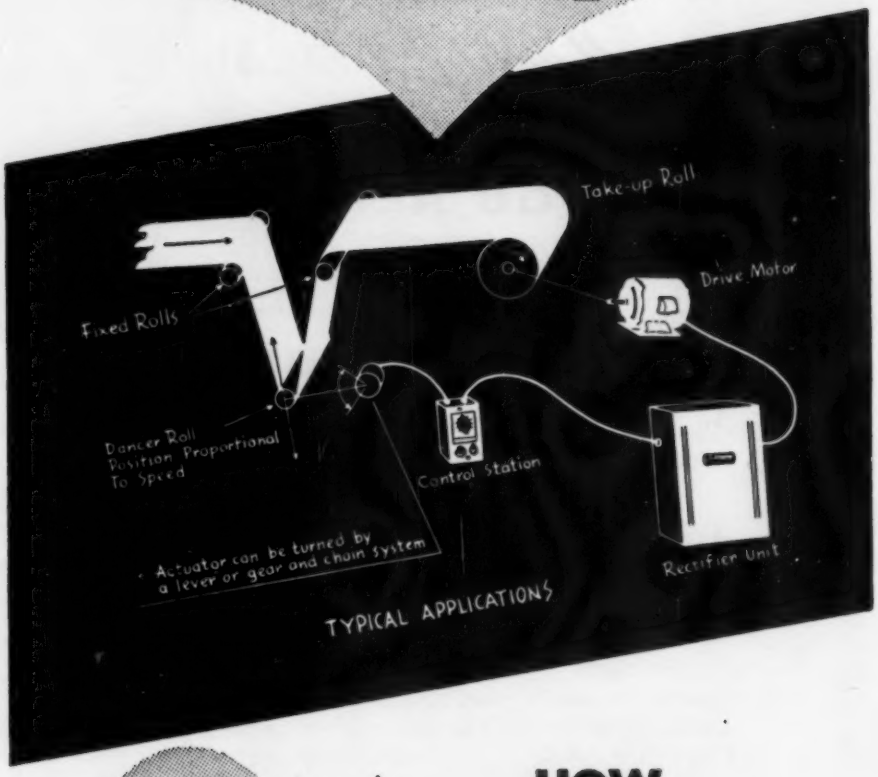

Here's HOW IT WORKS ...for Textile and Plastics Processing

A small tension change positions the actuator shaft so as to call for motor speed change to restore preset tension. Thus a constant linear feet per minute windup may be achieved even though the radius of takeup roll increases with each turn to otherwise increase linear speed versus radius build-up. Speed is now made proportional to position of dancer roll and tension is held essentially constant, as is the linear rate of material travel.

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Servospeed
4 Godwin Ave. Paterson, N. J.

"Quote . . . Unquote"

Plastic Foams in Ships

"In the areas of life saving equipment, boat buoyancy, void fillers, and float fillers it seems that plastic foams have substantially replaced the conventional buoyant materials of 10 years ago. The particular material to be used in the future will be determined largely by the individual merits of a material for a particular use. For instance, styrene-cored polyester glass covered ring buoys are being proposed as a competitor for currently-procured vinyl rings. Isocyanate foams are being investigated as a replacement for styrene boat buoyancy blocks.

"The three most important non-foam items of life saving equipment are inflatable rubber boats and glass fiber-filled and inflatable shipboard life preservers. It does not seem likely that foam products will replace any of these because of their particular operational advantages.

"For thermal insulation, the future of foams in ships may be very bright. The built-in moisture barriers of unicellular or nearly unicellular products and of those with freely formed skins is of special importance. The ease of applying by spraying or foaming in place, especially on irregular surfaces, indicates definite advantages. Generally, plastic foams will be lighter in weight and will be expected to maintain their properties longer than some insulations now used.

"The use of low-density plastic foams as cores in structural sandwiches will increase as more is learned about the specific engineering and economic requirements, and as foams are developed to satisfy these needs. Present indications are that such applications require foams which are unicellular, stiff, strong, and highly resistant to impact. An ideal foam might be one having the physical properties and cost of balsa wood with the unicellularity of styrene foam.

"As ship designers and builders become more familiar with plastic foams, there will be more and more use made of them. So far, there has been very little service experience with foams; too little to greatly influence the designers and builders of ships which are expected to have many years of dependable life. Plastic foams are natural materials, however, for naval service. They have two very important characteristics, that of being light in weight and being water excluders. The future will be good for foams in ships."

John B. Alfers, Head,
Plastics & Dielectrics Branch,
Bureau of Ships, Department of the Navy,
Washington 25, D. C.

• • •

NEWS in BRIEF

Outlook for plastics in 1957 is for continuing growth and expansion in both production and sales. Gains are expected to be led by polyolefins, reinforced plastics, and resin emulsion paints and coatings. Product sales will be highlighted by the further expansion of plastics into structural and other engineering applications.

Contamination by radioactive fall-out on Navy ships is guarded against by new wash-down systems utilizing vinyl plastic pipe and fittings (see page 827). Advantages include light weight, elimination of threaded joints, flexibility, and resistance to corrosion and marine growths.

Key to success for plastic materials suppliers is selling not only a product but also the service that goes with the product, says Carleton Ellis, director of plastics & resins sales for Barrett (see guest editorial, pages 806-7). These services should range from technical and application assistance to marketing help. Barrett's design-consulting service collaborates with customers in assuring proper application of Plaskon resins, as well as other and competitive materials.

New packaging method for liquid and semi-liquid food products has been introduced in this country by Crown-Zellerbach. Originally developed in Sweden, the method involves use of special paper and machinery to form tetrahedral packages with heat-sealed ends (see page 826).

Company acquisitions in the news last month included the purchase of P. R. Mallory's Plasteel division by Ekco Products, and the purchase of Lansco Die Casting by New Plastic.

Company expansions in plastics showed some decline in number from the preceding month's high mark. The first petrochemicals plant on the West Coast was opened by Carbide & Carbon in Torrance, Calif. Dewey & Almy will quadruple its pilot plant operations by building a new lab in Cambridge, Mass. DuPont is considering an increase in methanol production at its Orange, Tex., plant. A new lab and research center for cutting and splitting of foams is being opened by Falls Engineering in Cuyahoga Falls, O. Jefferson Chemical is expanding petrochemicals output at its Port Neches, Tex., plant. A full-scale plant for expandable styrene beads will be built by Koppers at Kobuta, Pa. Reichhold has added two formaldehyde plants in Detroit, Mich.,and Tuscaloosa, Ala., and has been licensed by Devoe & Reynolds to make epoxy resins.

Interest in nuclear research is becoming more and more active. A $750,000 nuclear reactor, the first privately-owned one of its type, is in operation at Battelle's new center in Columbus, O. Ten firms have joined forces in a new company to build and operate a nuclear reactor at Plainsboro, N. J. Budd has established a new facility at Philadelphia, Pa.. for the fabrication of radio-isotopes. A million-dollar lab to house Mellon Institute's department of radiation research will be built in Pittsburgh, Pa.

New Materials worthy of mention (see pages 832-3): non-reactive thixotropic agent; low-viscosity hardener for epoxy resin; combination stabilizer-thickener-leveling agent for emulsion paints; primary polymeric plasticizer for vinyls; acrylic finish restorer-cleanser-polisher; destaticizer for all plastic surfaces; heat-sealable, perforated polyester film; and a modified styrene resin for extrusion and injection molding.

New Equipment to be noted (see pages 834-5): rivet-type, threaded metal inserts; oven for preheating acrylic sheets prior to forming; automatic hopper loaders for injection machines; bench-model ovens; fully automatic, air-operated molding press; and automatic abrasion testing units.

New Products of special interest (see pages 836-7): adhesive for foamed styrene; abrasion-resistant, wrinkle-finish plastisol; extruded sheets of high-impact styrene copolymer; extruded tracks of high-impact modified styrene; extruded acrylic sheet; and molded alkyd tube sockets.

"fish eyes"

stalling production?

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PLASTICS TECHNOLOGY

DECEMBER, 1956

EDITORIAL: The Outlook for 1957

The outlook for the plastics industry in 1957 is for continuing growth and expansion in both production and sales. Any forecast of prospects for the coming year, however, should begin with the outlook for the chemical industry of which plastics are a part.

•

While chemical production and sales totals for 1956 are not available as yet, all indications are that both set new records this year and that current volumes will continue at least through the first half of 1957.

Chemical industry sales are now at the rate of $2-billion per month, indicating a total of more than $24-billion for 1956. This total is an all-time high, 4% greater than 1955. Chemical production volume this year should be 7% higher than 1955.

Capital expenditures for the chemical industry this year were at a record high of $1.5-billion, an increase of 47% over 1955. This figure brings the total chemical industry investment in new plants and equipment since 1946 to about $14-billion. Further gains are expected in 1957.

•

The optimistic outlook for plastics in 1957 is based on gains expected for polyolefin plastics, low-pressure reinforced plastics, resin emulsion paints and coatings, and the further expansion of plastics into structural uses.

Many new olefins will be available in commercial quantities in 1957, including the higher density polyethylenes. The greater heat resistances of these resins will lead a boom in consumer applications, while greater rigidity and toughness will bring increasing utilization in pipe, corrosion-resistant parts, industrial components, and other engineering uses.

Reinforced plastics recorded a 30% increase in sales this year over 1955 totals, and an equal percentage growth is predicted for 1957. Developments in resins, materials-handling methods, and surface finish of molded parts have led to the entry of reinforced plastics into new markets, and their increasing use as structural components in building, all forms of transportation, furniture, containers, and industrial parts. The improvements in processing have led to the entry of compression molders and other established manufacturers into the reinforced plastics field.

The impact of PVA and acrylic resin emulsions on the paint and coatings field has been well publicized, and further gains are expected in 1957. Significant gains also are looked for next year in plastic films and sheetings, particularly polyethylenes.

•

The most prominent feature of plastics during the past year has been the increasing emphasis on engineering applications, and the trend away from hit-or-miss uses and misapplications. The coming year will see even further advances in applications and other signs that the plastics industry is finally emerging into maturity.

Arthur M. Merrill

Editor

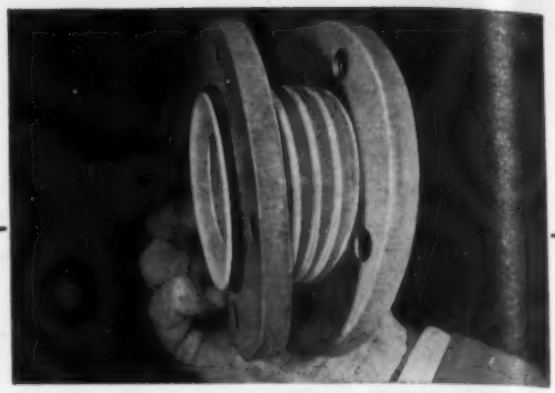
A TECHNICAL REPORT from Du Pont

• *Properties and application data on* Teflon® *tetrafluoroethylene resin*

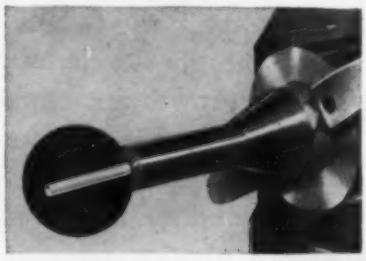
Chemical inertness and exceptional thermal stability are high on the list of advantages of Du Pont "Teflon" tetrafluoroethylene resin. The toughness and excellent dielectric properties of this engineering material add further to its versatility.

"Teflon" is nonflammable, and has zero water absorption by ASTM test D570-42. Often useful is its non-adhesive quality . . . materials will not stick to its surface. On the right, you see how engineers have made use of the unique properties of "Teflon" in three typical product improvements. Property data for Du Pont "Teflon" is shown below.

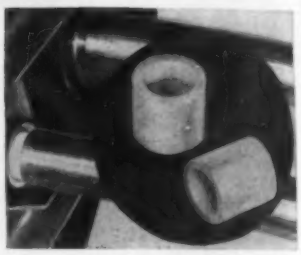
Take a close look at "Teflon" to evaluate it in terms of your own product design problems. For further information on "Teflon" write to: E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Department, Room 4912, Du Pont Building, Wilmington 98, Delaware. In Canada: Du Pont Company of Canada Limited, P.O. Box 660, Montreal, Quebec.



Pipe coupling uses flexible bellows of "Teflon." Flexibility of "Teflon" compensates for misalignment between pipe connections, and absorbs vibration. None of the chemicals normally found in industry affect "Teflon."



Extruded hose material of "Teflon" is strong, flexible, corrosion-resistant – assures long, trouble-free service. "Teflon" is unaffected by solvents and has a useful temperature range of −450°F. to 500°F.



Tough bushings of "Teflon" are used on this textile dyeing machine which operates under high-temperature conditions and pressure. The bushings are not corroded by the dyes, and do not distort from the heat or pressure. They require no lubrication.

MECHANICAL PROPERTIES			METHOD
Tensile Strength	73°F.	1,800 p.s.i.	D638-52T
	170°F.	1,100 p.s.i.	D638-52T
Elongation	73°F.	110%	D638-52T
	170°F.	600%	D638-52T
Modulus of elasticity	77°F.	58,000 p.s.i.	D638-52T
Shear strength		3,800 p.s.i.	D732-46
Impact strength, Izod	−70°F.	2.0 Ft.-lb./in.	D256-47T
	73°F	3.0 Ft.-lb./in.	D256-47T
Stiffness	73°F.	60,000 p.s.i.	D747-50T
Flexural strength	73°F.	Did not break	D790-49T
Compressive stress at 1% deformation		600 p.s.i.	D695-52T
Creep in flexure		67	*
Hardness, Durometer		D50-D65	D676-49T
Static or kinetic coefficient of friction against polished steel		0.04	Various methods used

THERMAL PROPERTIES		
Coefficient of linear thermal expansion per °F.	5.5×10^{-5}	D696-44
Thermal conductivity	1.7 B.T.U./hr./sq.ft./°F./in.	Measured by Cenco-Fitch
Specific heat	0.25	
Deformation under load at 122°F., 2000 lb./sq. in., 24 hrs.	25%	D621-48T
Heat-distortion temperature		
264 lb./sq. in.	140°F.	D648-45T
66 lb./sq. in.	250°F.	D648-45T

ELECTRICAL PROPERTIES		
Dielectric strength, short-time, 0.080 in.	400-500 v/mil	D149-44
Volume resistivity	$> 10^{15}$ OHM-CM	D257-52T
Dielectric Constant, 60 cycles	2.0	D150-54T
10^3 cycles	2.0	D150-54T
10^6 cycles	2.0	D150-54T
10^8 cycles	2.0	D150-54T
Power factor, 60 cycles	< 0.0003	D150-54T
10^3 cycles	< 0.0003	D150-54T
10^6 cycles	< 0.0003	D150-54T
10^8 cycles	< 0.0003	D150-54T

CHEMICAL PROPERTIES	
Resistant to:	all chemicals except molten alkali metals and fluorine (under elevated temperatures and pressures)

MISCELLANEOUS PROPERTIES		
Water absorption	0.005%	D570-42
Flammability	nonflammable	D635-44
Specific gravity	2.1–2.2	D792-50
Resistance to weathering	excellent	D392-38
Basic color	light opaque	

*Term "creep in flexure" is a measure of the deformation under a prolonged standard load. Results here represent mils deflection in 24 hrs. of a 1/8" x 1/2" bar, 4" span, center-loaded flatwise to 1000 lb./sq. in., minus the initial deflection.

NOTE: This table shows the typical property data for Du Pont "Teflon" tetrafluoroethylene resin.

ZYTEL® nylon resin · **ALATHON®** polyethylene resin · **TEFLON®** tetrafluoroethylene resin · **LUCITE®** acrylic resin

DU PONT
REG. U. S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*

PLASTICS TECHNOLOGY

Polymeric Adhesives for Glass

A discussion of the chemical nature, formulation, properties, and suitability of polymeric adhesives for glass bonding.

FRANK MOSER, *Research Chemist*

Research Laboratories, Glass Division,

Pittsburgh Plate Glass Co., Creighton, Pa.

POLYMERIC materials are the main constituents for glass adhesives. The ones that are most promising for glass surfaces are selected on the basis of polarity, available functional groups, and compatibility. The polymer and the glass should have certain characteristics in common with respect to expansion and contraction coefficients, flexibility, and chemical groups so that a more permanent adhesion will result.

Polar materials containing such functional groups as –OH, –COOH, –C=O, and $-COOCH_3$ are suitable for bonding glass. Polymeric substances having such chemical structure are the epoxies, butyrals, polyvinyl acetate, copolymer vinyl chloride-acetate-alcohols, and polyacrylates. Various combinations of these resins with either phenolic or butadiene-acrylonitrile polymers are used most commonly for formulating glass adhesives.

Polarity of the material is a very convenient guide for selecting suitable polymers for adhesive formulations. DeBruyne (1)* has discussed this suggestion, and claims that similar polarities are essential for good adhesion. The adhesion of dissimilar material is more difficult. As others (2,3) have reported, the surfaces must be matched by adjusting the polarity either by a primer coating or by the formulation of a bifunctional adhesive molecule.

*Numbers in parentheses refer to bibliography at end of article.

Frank Moser was born in Iowa in 1901. He received a B. S. degree from Iowa State College in 1927; an M. S. degree in 1929 from Purdue University; and a Ph. D. in 1932 from Cornell University. He served as a research assistant at Purdue University from 1927-29; director of science and agriculture at State Teachers College, Dickinson, N. D., from 1929-30; research assistant at Cornell University from 1930-33; division supervisor for Northwestern Mutual Life Insurance Co. from 1933-36; associate agronomist at Clemson College from 1936-44; and joined Pittsburgh Plate Glass Co. in 1944, and is in charge of fundamental investigations of adhesion and the formulation of glass adhesives.

Dr. Moser is a member of the American Chemical Society, American Society for Testing Materials, Sigma Xi, and Pi Kappa Alpha. He has been active in A. S. T. M., especially in Committee D-14 on adhesives, and has served as an officer of various sub-committees. He is the author of many technical publications, and has written popular articles on farm crops and soils, and poultry production. He currently resides in Sarver, Pa., with his wife, son, and daughter.

Table 1. Polymerized Monomers as Glass Adhesives.

	Bond Strength under Tensile Load, Psi.	Type of Bond Failure
Vinyl acetate	500	Adhesion
Vinyl acetate-methyl methacrylate	300	Adhesion
Vinyl acetate-styrene	100	Adhesion and contact
Phthalic anhydride-glycerol	100	Contact
Phthalic anhydride-glycerol-maleic anhydride-styrene	300	Adhesion
Phthalic anhydride-glycerol-vinyl acetate	200	Adhesion
Bisphenol-epichlorohydrin	600	Adhesion
Bisphenol-epichlorohydrin-tricresyl phosphate	1,000	Adhesion

Table 2. Polymeric Substances as Glass Adhesives.

Polymers	Bond Strength under Tensile Load, Psi.	Type of Bond Failure	Polarity (Contact Angle)
Polyvinyl acetate (AYAF)	550	Adhesion	25-28°
Polyvinyl acetate-dibutyl phthalate	1,200	Adhesion	18-20°
Polyvinyl chloride-acetate (VMCH)	400	Adhesion	65-67°
Polyvinyl chloride-acetate (VYHH)	100	Contact and adhesion	60-62°
Polyvinyl chloride-acetate alcohol	1,200	Largely glass	24-26°
Polyvinyl butyral-dibutyl phthalate (XYHL)	1,200	Adhesion	18-20°
Methyl methacrylate	0-100	Very little if any adhesion	62-64°
N-propyl methacrylate	200	Adhesion	63-65°
Polyvinyl alcohol	400	Adhesion	14-15°
Polyvinyl chloride	0-100	No adhesion	66-68°
Cellulose nitrate	200	Adhesion and contact	36-37°
Ethyl cellulose	0-50	No appreciable adhesion	60-61°
Phenolic (Durez 12987)	500	Adhesion	22-24°
Phenolic (Br 17620)	300	Adhesion	38-40°
Substituted phenol-aldehyde (BV-1112)	100	Adhesive too brittle	43-44°
Aryl sulfonamide-formaldehyde (MS-80)	100	Cohesive	33-35°
Styrene-butadiene (Pliolite S-5)	0-100	No appreciable adhesion	70-72°
Cyclized rubber (Pliolite S-50)	100	Little adhesion	37-40°
Neoprene Type GN-A	0-100	Adhesive	35-38°
Butadiene-acrylonitrile (Hycar OR-15)	200	Cohesive	35-36°
Epoxy: Epon 1062	500	Adhesion	20-23°
Epon 824	200	Adhesion	50-52°
Epon 1001	400	Adhesive	60-62°

Bond Strengths

Adhesion of polymeric-type adhesives to glass was evaluated by measuring the bond strength under tensile loading. The method of test is the cross-lap tensile test of ASTM D1344-54T.

All heat-curing adhesives were bonded according to the following procedure: after coating the glass, a one-hour air drying period was allowed, followed by a ten-minute heat activation at 250° F., assembly under 200 pounds pressure, and curing for 45 minutes at 275° F. For the room-temperature epoxies, the glass was coated with the catalyzed adhesive, assembled under contact pressure, and allowed to age for seven days at room temperature before testing.

In Table 1, an attempt is made to show the strengths of adhesive assemblies bonded by polymerizing monomers or various mixtures of monomers between test specimens of glass. Some of the monomeric combinations were partially polymerized to a fairly syrupy stage before placing between the test pieces for final cure. In this test, only clear monomers were checked for bond strength and compared with the adhesion obtained from the same type polymer.

The polymerized vinyl acetate gave a 500 psi. bond strength value which compares quite favorably with the strength of the unplasticized polyvinyl-acetate adhesive. When monomeric vinyl acetate and methyl methacrylate were copolymerized between glass, a bond strength of 300 psi. was obtained. This reduction in strength may have been due to the blocking out of some of the func-

tional groups by the copolymerization of methyl methacrylate and the glycerol phthalate.

Other examples of the polymerizing types are given, but the strengths remain relatively low except for the styrene-phthalic-anhydride-glycerol-maleic anhydride combination which gives a 300-psi. bond having excellent clarity.

The bisphenol-epichlorohydrin combination gives a good bond, 600 psi. However, these were partially polymerized and then cured between glass. In most cases, the adhesion secured by polymerization in place is not too advantageous, since short pot life is objectionable and the strengths of the polymerized adhesives are often influenced by brittleness and other undesirable physical properties.

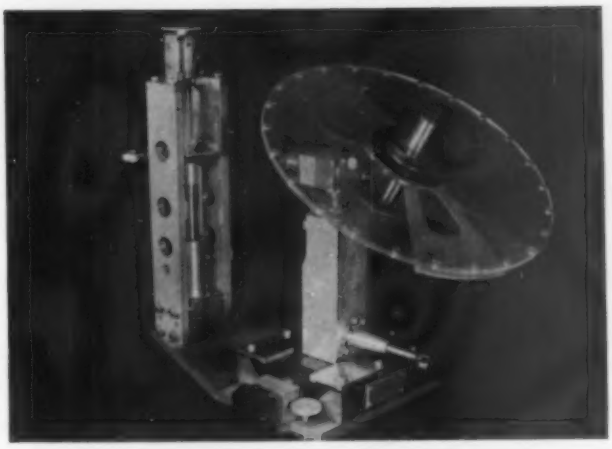


Fig. 1. Contact angle testing instrument.

Polymeric Adhesives

Respective polymers were put into solution by means of appropriate solvents, and tested on glass assembled according to the recommended procedures previously outlined. A listing of the polymers that may be used in adhesive formulations is given in Table 2. The bond strength and the type of bond failure are shown, together with the respective polarity of the plastic film as given by contact angle measurement in air-water systems. As a rule, the pure polymers are not the most desirable glass adhesives since an improvement in strength or in physical properties is often obtained by combining with other resins or by the addition of a plasticizer.

An examination of the polymeric substances in Table 2 shows that all the respective materials used singly give relatively low strength, and all produce an adhesion failure. The ones giving good adhesion are the copolymer vinyl chloride-alcohol, plasticized polyvinyl acetate, and plasticized polyvinyl butyral. The more brittle phenolics and the slightly non-polar resins give either adhesion or contact failures. Some of the epoxies give fair strength, but these also are improved by addition of plasticizers.

Most of the polymers listed in Table 2 are used in adhesive formulations giving some adhesion to a glass surface, but the amount of adherence is influenced by the polymers' physical and chemical properties. In some instances, adhesion is impaired by brittleness; in others, lack of wetting of the highly non-polar materials causes the resinous material to squeeze out at the edges of the test specimens, leaving an unsatisfactory adhesive film and little if any adhesion.

Many of the flexible materials may be combined with the more brittle resins, thereby producing desirable bonding mixtures. In formulation, a rating of the polarity of the materials is often very beneficial for selecting adhesives for glass or for bonding glass to other solids.

Contact angles provide a means for establishing the polarities of surfaces and adhesive materials. The method used for determining these angles is a modification of the captive bubble method described by Wark and Cox (4). The testing instrument is shown in Figure 1, and its application has been described (3). In brief, the method is as follows: The surface to be tested is placed in the glass cell containing distilled water, then a bubble of air is placed on the holder and lowered until contact is made with the specimen surface. The contact angle is read directly by placing the cross-hairs of the telescope on a line with the tangent to the bubble.

In classifying materials by their contact angles, angles from 0-20° denote polar materials; 21-44° denote slightly polar materials; 45-70° denote moderately non-polar materials; and 71-100° denote non-polar materials. Desirable resins in adhesives for a specific surface are those in the same polarity classification as the surface material itself.

Figures 2-5 illustrate the use of contact angles for establishing the polarities of surfaces and adhesives. In out tests, we found that a glass surface has a 0° (polar); nitrile rubber has a 15-20° angle (polar); natural rubber has a 30-35° angle (slightly polar); and butadiene-styrene rubber has a 62-63° angle (moderately non-polar). In other tests, not illustrated in this paper, we found that a Durez 12687 phenolic film has medium polarity; chlorinated rubber is highly non-polar; Durez 12897 phenolic film is polar; and Hycar nitrile rubber gives a polar surface film on glass.

Adhesive Formulation

Several compounds usually are desirable in adhesive formulations. For example, polyvinyl butyral may be modified by the addition of other materials to yield a higher bond strength than when used either alone or with a suitable plasticizer. A bond strength of 600 psi. is obtained from the pure butyral, while the addition of dibutyl phthalate as a plasticizer increases the strength to 1,000-1,200 psi.

Table 3 shows the effect of varying the ingredients of adhesive formulations. Polyvinyl butyral is an excellent base material for a glass adhesive, but is somewhat lacking in moisture resistance and low-temperature flexibility. Consequently, our adhesive formulations have been centered around modifications of this polymer.

Contact angle determinations for polarity have indicated that certain pure phenolics, substituted phenol-aldehydes, cyclized rubber, and butadiene-acrylonitrile polymers are compatible. A combination of butyral with any of these polymers should give an improved adhesive. A substituted phenolic resin (Bakelite BV-1112) may

Table 3. Combinations of Polymeric Substances as Glass Adhesives.

Polymer Combination	Bond Strength Psi.	Type of Bond Failure
Polyvinyl butyral-cresylic phenol	2,800	Adhesive
Polyvinyl butyral-oil and ester gum modified phenolic	1,900	Cohesive
Polyvinyl butyral-terpene phenolic	1,100	Glass surface
Vinyl copolymer (chloride-acetate-alcohol) vinyl butyral-phenolic	1,700	Cohesive
Polyvinyl chloride-acetate-alcohol with phenolic	1,800	Cohesive
Polyvinyl chloride-acetate with a phenolic	800	Cohesive
Phenolic-Buna N (Durez 12987-Hycar 1032)	1,400	Glass
Phenolic-butadiene-acrylonitrile (Durez 12687-Hycar 1032)	1,000	Adhesive and some cohesive
Cyclized rubber-polyvinyl chloride acetate	500	Adhesive
Polyacrylate-Buna N (Hycar 1032)	400	Adhesive
Polyamide-epoxy	1,200	Adhesion

Table 4. Commercial Adhesives Most Desirable for Glass.

Chemical Type	Bond Characteristics		
	Strength, psi.	Type of Failure	Weathering Qualities
Phenolic-polyvinyl butyral	1,600-5,500	Glass	Good
Phenolic-butadiene-acrylonitrile rubber	1,000-1,200	Adhesion	Good
Vinyl-butadiene-acrylonitrile rubber	1,200-3,000	Adhesive	Fair
Neoprene-base	1,000-1,200	Adhesion	Poor
Thiokol	200-400	Cohesive	Good
Rubber-base	200-800	Adhesive and cohesive	Fair to poor
Silicone	200-300	Largely cohesive	Good
Cellulose, Vinyl	600-1,000	Adhesive	Poor
Epoxy	600-2,000	Adhesive on glass	Fair

be used for modifying the butyral as it is moderately polar and soluble in mutual solvents. When mixed in equal proportions on a solid basis, the combination gives a bond on glass surfaces of 2,000 psi. and having fairly good weathering qualities.

A combination of a terpene-phenolic resin with polyvinyl butyral did not increase strength too much (1,100 psi.), but this mixture gave a glass surface bond failure which indicated stress concentration at the glass-adhesive interface. More desirable adhesives with respect to stress concentrations at the interface are obtained with cohesive type failures. Thus, additional combinations were tested. One of the better formulations was obtained by combining a tung oil-modified phenolic resin further modified with ester gum with a polyvinyl butyral. Such modified phenol-butyral adhesives give excellent adhesion to glass, with good bond clarity and moisture resistance. Bond tensile strengths up to 2,000 psi. may be obtained.

Other polymer mixtures producing a cohesive-type failure were obtained from combining a copolymer vinyl chloride-acetate-alcohol, a polyvinyl butyral, and a substituted phenolic. A bond strength of 1,700 psi. was obtained, while 1,800 psi. was possible when the copolymer was mixed only with a phenolic resin. In both cases, cohesive failure was prevalent.

Butadiene-acrylonitrile-phenolic and the vinyl-butadiene-acrylonitrile combinations are desirable where more flexible bonds are needed. These combinations are used in quite a number of available commercial adhesives which are suitable for glass as well as for glass-to-metal. A Durez phenolic resin 12987-Hycar 1032X1 formulation gave 1,400 psi. under tensile loading with glass failure, while the Durez 12687-Hycar 1032 resins gave only 1,000 psi. with adhesive failure from the glass.

This type of adhesive failure can be attributed to the phenol portion of these combinations. The Durez 12687 resin is decidedly more non-polar than the 12987 resin and, therefore, is slightly non-compatible with the glass surface, resulting in adhesive failure. The acrylate-Buna N resinous mixtures are not too suitable for glass, giving only 400 psi, with adhesion failure. This mixture employed a polymethyl methacrylate and undoubtedly was somewhat too non-polar for the glass surface. More adhesion would probably occur if a polyethyl acrylate was used with the Hycar 1032X1 resin for bonding glass.

Heat-curing epoxies are ideally suited for glass surfaces. A mixture of Epon 1001 with Polyamide 100 makes a very desirable adhesive, and this combination is further improved by the addition of tricresyl phosphate plasticizer.

Commercial Adhesives

This paper would not be complete without a discussion of the available commercial adhesives. In Table 4

are the results that can be expected from various adhesives that are grouped according to chemical types. The selection of an adhesive is entirely dependent upon the bond characteristics desired. In the glass industry, we are always desirous of maintaining clarity of bond and, therefore, are more partial to the adhesives that give transparent bonds. In cases where the fabrication demands other bond properties, a colored bond is acceptable.

The phenolic-polyvinyl butyrals group gives the highest tensile and shear strengths. When cured as specified earlier in this paper, bond strength varies from 1,600-5,500 psi. usually giving glass failure and good moisture resistance. Manufacturers of such adhesives are the Bakelite Co., B & B Chemical Co., Armstrong Cork Co., Chrysler Corp., and others.

The phenolic-butadiene acrylonitrile types give a colored bond and good permanent adhesion, but the strength obtained is from 1,000-1,200 psi. Some of these adhesives specify higher cure temperatures than are suitable for glass; when cured at lower temperatures, a sacrifice in total bond strength is made. Manufacturers of this class of adhesives are Minnesota Mining & Mfg. Co., Armstrong Cork Co., and B. F. Goodrich Co.

Very good glass-glass bonds are obtained with the vinyl-butadiene acrylonitrile rubber type adhesives. These usually have goood flexibility and are suggested for bonding glass-to-metal and in glass fabrications where bond color is not objectionable. To obtain a tensile strength as high as 3,000 psi., a preheat period of 10 minutes before assembly and curing is recommended. Where heat cures are not permissible, the adhesives may be heat-activated with heat lamps for 15 minutes before assembly, but the strength obtained will be in the lower range of values shown in Table 4. This type of adhesive can be secured from numerous manufacturers; those tested in our laboratory were supplied by Minnesota Mining & Mfg. Co. and Goodyear Tire & Rubber Co.

Neoprene-base adhesives will bond glass to glass, but give opaque or dark colored bonds and are used mainly for bonding glass to other materials. These are largely solvent-type adhesives and cure very slowly at room temperature, but the bond is improved in tensile strength by heat activation. They are used mainly for bonding

(Continued on page 805)

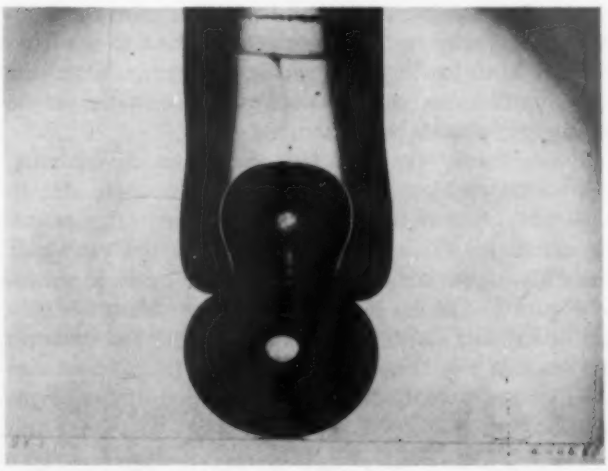


Fig. 2. Contact angle photograph of a glass surface.

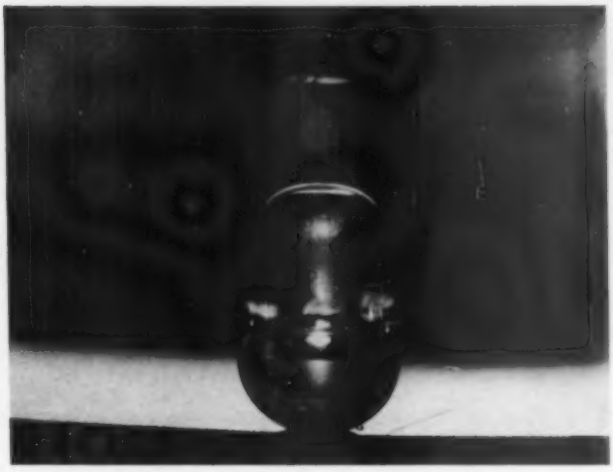


Fig. 3. Contact angle photograph of a nitrile rubber surface.

Fig. 4. Contact angle photograph of a natural rubber surface.

Fig. 5. Contact angle photograph of a butadiene-styrene copolymer rubber surface.

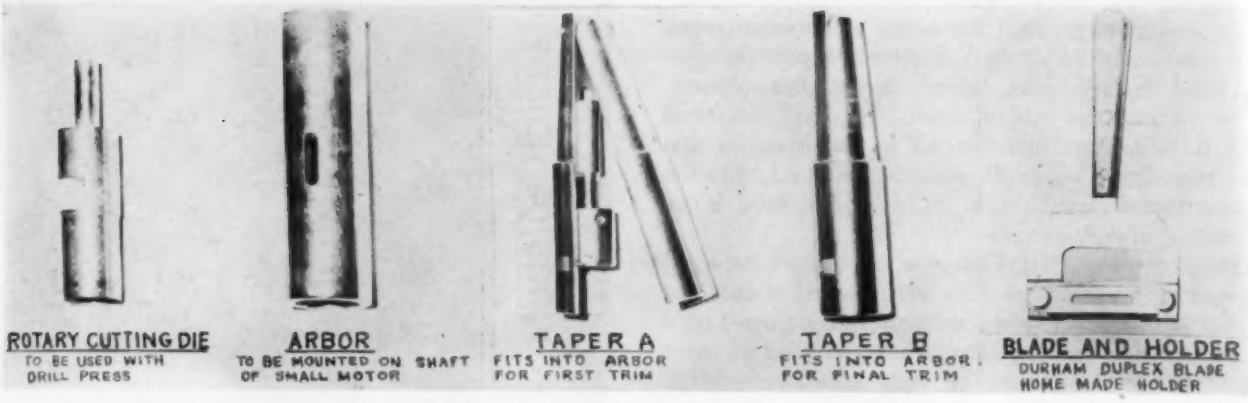


Fig. 1. Sample trimming jig set consists of five components.

Sample Preparation Jig for Cellular Products

Details of a method of sample preparation which gives such uniformity of sample size that measurement of individual samples can be eliminated.

In testing cellular products and especially flexible foams, a major problem is sample preparation. Molding the sample to a given size and shape often presents many difficulties, such as amount of material to be used, mold design, skin formation, etc. In many cases, the sample must be taken from a product of complicated shape.

Many laboratories use a slitter or bandsaw to cut rectangular blocks from the products or from larger test blocks. The definition of such a sample requires at least three and preferably six measurements. Other laboratories prepare a slab of desired thickness, and then stamp out a sample of desired cross-sectional shape. This usually results in samples having concave sides. It is also difficult to cut slabs from odd-shaped pieces.

We have developed in our laboratory a method of sample preparation which overcomes these difficulties. We use a cylindrical sample of one square inch in cross-sectional area (diameter = 1.129 inches) and one inch in height. This particular sample size has many advantages: its weight represents its density in grams, ounces, or pounds per cubic inch; the force in grams, ounces, or pounds to deform to any deformation gives the load-bearing capacity in fundamental units; and it is a convenient size for making tensile specimens since the breaking force in pounds would give directly the tensile strength in pounds per square inch, etc.

Furthermore, we have developed a set of trimming jigs which enables the reproduction of sample size so accurately that measurement of individual samples can be eliminated. This results in a substantial saving of time. The jig set consists of five separate items, as shown in Figure 1. The die is used in any conventional bench-top drill press, and the arbor (female taper) mounts on the shaft of a ⅛-¼ hp. motor. The two taper assemblies are identical except for the exact position of the height adjusting plug.

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Figure 2 is a cross-sectional assembly drawing showing the details of their construction. Each taper is hinged at the small end and opens to permit insertion of the sample. When inserted, the sample is held in place by two small needle points. The adjusting plug (4) can be set for any sample height by adjusting its position on stud (3). Three locknuts are provided to fix it in position. One is always accessable with a screw driver.

The plug of taper A is adjusted for a height of 1 1/16 to 1 1/4 inch; that of taper B for a height of exactly one inch. The jig permits any final height up to 1.5 inches, but could be designed for any other desired height.

In sample preparation, a cylindrical section is cut out with the rotary cutting die from any shaped piece of cellular material having a thickness of about on-half inch in excess of the desired sample height. It is then put into Taper A and one end is trimmed off by sliding the blade edge across the end face of the taper while it is in rotation.

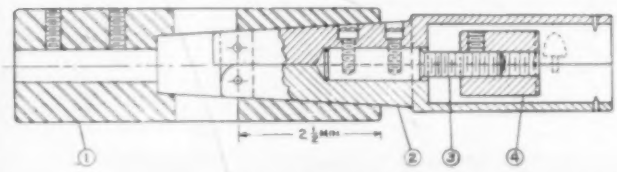

Fig. 2. Cross-sectional drawing of arbor and chuck assembly. Legend: 1. Arbor; 2. Taper chuck; 3. Stud; and 4. Adjusting plug.

Next, the sample is put into Taper B with the trimmed face against the height adjusting plug, and the remaining rough end is trimmed off. The angle between the blade and the end face of the taper should be small to prevent concave ends. A slight amount of lubrication with Dow Corning Fluid 200, 50-centistoke variety, on both the rotary cutting die and the blade is very helpful.

The above procedure can be carried out very rapidly with excellent reproducibility. Fifty consecutive samples were prepared and found to have a diameter of 1.128 ±0.001 inch, and a height of 1.000 ±0.005 inch. With this reproducibility, the error involved by assuming a constant cross-sectional area of 1.00 inch and a 1.000 inch height is well within the experimental error of the finest test methods for cellular materials.

—THE END

Polymeric Adhesives for Glass
(Continued from page 803)

felt to metals or glass, and for bonding glass foam to basic structures. Manufacturers of this type of adhesive are too numerous to list.

The Thiokol and silicone paste adhesives give low tensile strength, but good water resistance. They have only limited use as sealers, or for temperatures up to 250° F. Such adhesives may be obtained from Minnesota Mining & Mfg. Co. and Dow Chemical Co.

The rubber-based group takes in a wide variety of materials and may be compounded from natural, Buna S (butadiene-styrene), Buna N (nitrile), or reclaimed rubbers. They are used for a wide variety of adhesions, and are very useful for interior use to adhere glass to innumerable surfaces. Most adhesive suppliers have such adhesives for sale.

The epoxy adhesives are a recent development, and include both heat-setting and room temperature-setting types. They are especially desirable for glass because of their setting properties and the need for only contact pressure during the cure. These resins have low shrinkage, good clarity, and high bond strength, but some are lacking in moisture resistance especially under high humidity. The heat-curing types are moisture resistant, but their curing temperatures are too high for glass. The epoxy adhesives may be obained from Ciba Co., Bakelite Co., Chrysler Corp., Borden Co., Glasbau Heinrich Hahn, and Houghton Laboratories.

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—THE END

Guest Editorial

Sell Service—Plus

CARLETON ELLIS, JR., Director of Plastics and Resin Sales
Barrett Division, Allied Chemical & Dye Corporation
New York, N.Y.

THE key to continuing success for plastics materials suppliers is selling not just a product—but, importantly, the service that goes with it. These services can and should range from technical and application assistance all the way through to marketing help when and where indicated.

Customers cannot always match their suppliers' facilities in these areas. Too, there are some specialized services that the supplier of a broad line of plastics materials is better equipped to offer. The Barrett organization is ready to offer just such customer assistance in the form of the Plaskon Design Consulting Service.

Our Plastics and Resins Sales Group, as a sales and market development function, maintains a full-time professional industrial designer, Bob Rockwood. His services are available to Barrett's customers and their customers alike. He functions to guide designers and engineers in the proper use of plastics materials from the standpoints of appearance, function, and manufacturing suitability. In some cases, he has actually created the need for a product fabricated in plastics (and not always *our* plastics, helped line up a molder or fabricator, and then supervised the technical phase of putting a job into production.

This captive design function is not designed to "sell" specific plastics, but is designed to "sell" the prestige of plastics when properly applied. Such applications, sound and appropriate, will produce sales soon enough by their own natural momentum.

The Barrett designer, working closely with research and field service, is available to collaborate as closely as desired in the application of Plaskon molding compounds and industrial resins. But if a design calls for another material, a competitive plastic or possibly even metal, he will be the first to say so.

This design-consulting service has been in operation for almost three years. Leading designers and a great many manufacturers have been visited. Our design-consultant has traveled more than 1,000,000 miles, and delivered numerous talks before many different types of audiences.

We are convinced that this service, telling the plastics industry's story as well as Barrett's own story in depth, to the right people at the right time, is one of the soundest investments the materials supplier can make for his own and the industry's benefit.

—THE END

Carleton Ellis, Jr. (right), discusses application recommendations for newest Plaskon material with Barrett industrial design consultant, Bob Rockwood.

Bob Rockwood, Barrett industrial design consultant, discusses plastics applications with leading designers.

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Effect of Long-Term Loading on Glass Fiber-Reinforced Plastic Laminates*

A progress report on results after one year of tests on two polyester and one epoxy resin laminates.

An experimental investigation of the stress-rupture and creep characteristics of glass fiber-reinforced plastic laminates has been in progress at the Forest Products Laboratory, in cooperation with the Bureau of Ships, Navy Department, for more than a year. Since the investigation is to continue for several years, complete data will not be available for some time. This interim report presents such data as are currently available.

Reinforced plastics, in common with other structural materials, are known to fail under long-continued loads at stresses less than the ultimate stress developed in standard short-time tests. In developing design criteria for shipboard applications, such as hulls, decks, roofs, piping, and pressure vessels, the periods during which the laminates are under continuous loads are measured in years. It is, therefore, the general object of this study to obtain stress-rupture data in tension, flexure, and shear on typical reinforced plastic laminates for periods up to five years.

This interim report presents the data obtained over approximately the first year of the study. Strain data in tension and flexure are available in some cases for periods up to 10,000 hours. Stress-rupture data, however, are limited to shorter periods; that is, the greatest time to failure for which data are available is on the order of 4-8 months. Some specimens are still carrying

*This report is one of a series prepared by the Forest Products Laboratory under U. S. Navy Bureau of Ships Project Order No. 10746/55, Amendment No. 1, dated April 27, 1955.

loads after about a year; these furnish strain data, but not stress-rupture data as yet. The work on shear has been essentially exploratory, so that data are available only for limited durations. Strains were not measured in shear, so creep data are not available.

A mathematic evaluation of the tensile creep data is presented, so that the strains and strain rates of the materials may be compared. Constants obtained from the test data over short periods were used to predict the strains over long periods. A comparison of predicted and observed strains is included in the discussion of results.

Several variables are incorporated in this research. Stress-rupture data are being obtained on four types of glass-fiber-reinforced plastic laminates. Specimens of each type are being loaded in tension, flexure, and shear. The specimens are being tested at 73° F. and 50% relative humidity, and while immersed in water at 73° F.

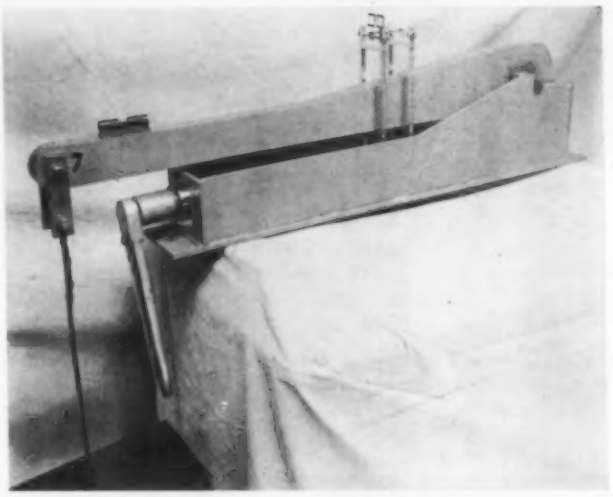


Fig. 1. Apparatus used for long-term tensile stress-rupture tests.

Nature of Test

Text Materials

The four types of glass-fiber-reinforced plastic laminates being tested in this study are:

(1) Polyester laminate (Selectron 5003 resin plus 181 glass fabric with 136 finish).
(2) Polyester laminate (Selectron 5003 resin plus a 1½-ounce glass mat).
(3) Polyester resin (Selectron 5003 resin plus United Merchants 1000 glass fabric).
(4) Epoxy laminate (Epon 828 resin with curing agent CL, plus 181 glass fabric with Volan A finish).

Materials (1), (2), and (4) are currently being tested. Material (3) was on order at the time this paper was prepared. The quality of the laminates is indicated in Tables 1-6, which show the tensile and flexural properties that were obtained by standard testing methods (Federal Specification LP-406b). Table 7 shows the results of a limited number of Johnson shear tests.

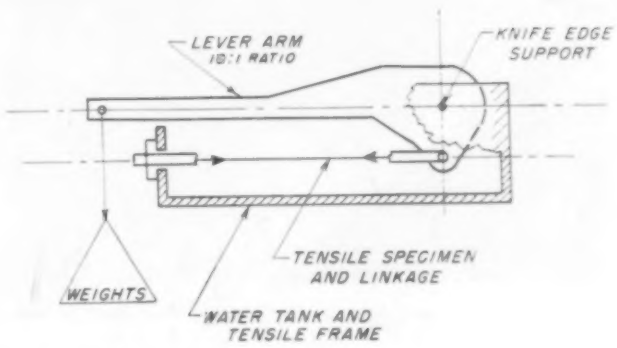


Fig. 2. Schematic drawing of tensile stress-rupture apparatus.

Test Equipment

The long-term tests were carried out in equipment designed and fabricated at the Forest Products Laboratory. The equipment in each case was designed to apply load with dead weights and a lever system.

The design of the loading system for the tensile tests (see Figure 1) was complicated because some of the test had to be made with the specimen immersed in water. The equipment for applying tensile loads consists essentially of a weight platform, a horizontal lever, and the necessary grips and linkages, all on or in a horizontal tank in which the specimen was tested in a horizontal position, as indicated in Figure 2.

Strain measurements on the tensile specimens were also complicated by immersion of some of the specimens. That is, strains under water had to be transformed into measurable movements out of water. The extensometer used is shown in Figures 3 and 4. Essentially, it consists of a system of levers and mirrors that provide both mechanical and optical magnification.

The flexure apparatus (Figures 5 and 6) is more conventional. It consists simply of a horizontal beam pivoted in such a way that a vertical load is applied at midspan

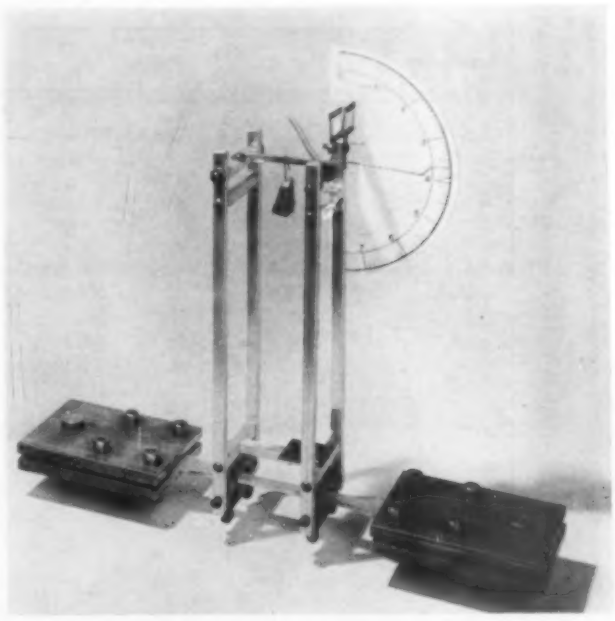


Fig. 3. Tensile creep extensometer used to measure strain.

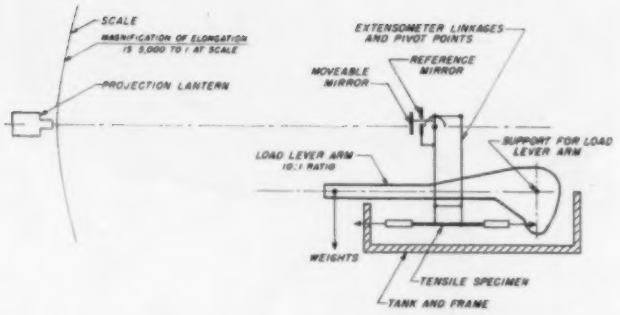


Fig. 4. Schematic drawing of extensometer linkages and method of magnification of elongation.

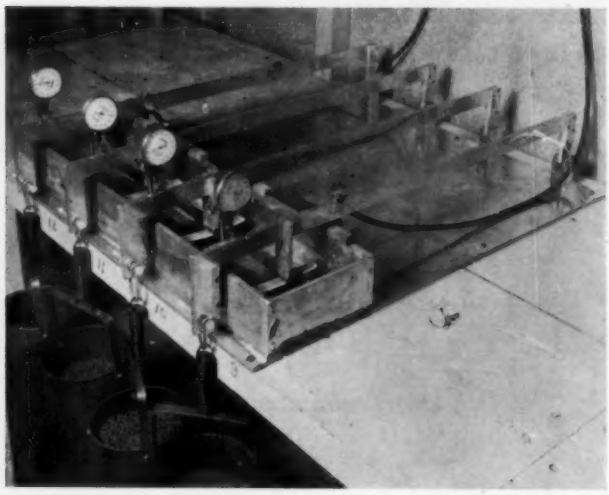


Fig. 5. Apparatus used for long-term flexure stress-rupture tests.

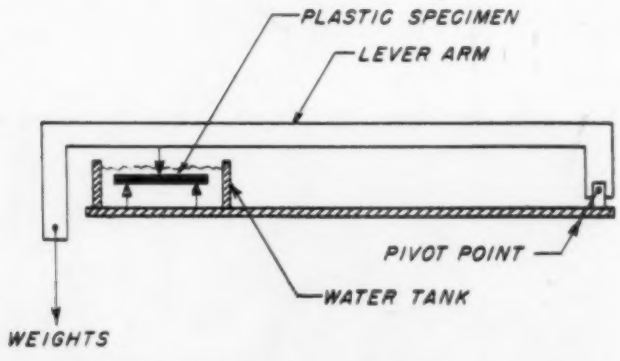


Fig. 6. Schematic drawing of long-term stress-rupture apparatus.

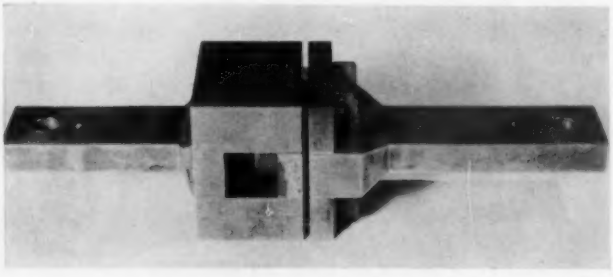


Fig. 7. Johnson shear test tool.

of a specimen supported in a tank. Deflections are measured with a dial gage reading to 0.0001-inch.

Existing equipment for application of dead load was utilized by devising a shear-test tool of the Johnson type (see Figure 7) to which tensile rather than compressive loads could be applied. Load was applied by the tensile equipment previously described, with the shear tool replacing the tensile grips.

A number of the devices were equipped with electric timers to determine time to failure in short-time tests. Where the time to failure was expected to be in excess of about 2,000 hours, however, such accurate timing was considered unnecessary. The equipment for the longer tests was arranged so that failure of any specimen was signalled by an electric light, and the time to failure could be determined to the nearest day.

Method of Test

After the quality of the various laminates had been determined by standard short-time loading methods in universal testing machines, stress-rupture data were obtained in mechanical lever systems that used weights for application of the load. The load that was applied to the lever arms was determined by the calibration of the lever system, the size of the specimen, and the steady stress desired.

The first two laminate materials (#1 and #2) were intended to have stress durations up to five years. Stress levels were chosen at 5% intervals from 40-80 percent of maximum strength. Specimens for test at all stress levels were loaded at approximately the same time. Since the wet specimens failed at lower stress levels than had been anticipated, the applied stress range had to be lowered to 30%. The specimens being given exploratory shear test and the two materials that were incorporated later in this program (#3 and #4) are being loaded first at the higher stress levels in order to quickly ascertain their trends at high stress levels.

The loading weights are supported on a jack while the specimen is being installed on its supports or in its clamps. The weights are then lowered slowly so that the total load is applied to the specimen in about two minutes. While the load is being applied, the deflection of the flexure specimen or the strain in the tensile specimen, as the case may be, is observed. The deflection or strain indicators are reset if the movement exceeds their capacity.

The moment at which, in the opinion of the operator, the specimen completely supports the weights is the beginning of creep time and of observed creep (strain at constant stress). Elongations or deformation are then recorded at several intervals during the first hour, then at increasing intervals to about two days, after which readings are taken about once a month. Strain data have not been obtained on the shear tests.

Test Data

Tables 1-7 present data from short-time standard tests to serve as controls for the establishment of stress levels in the long-term tests. In some instances, these tables also show the strength after one year under either standard conditions or water immersion.

Tables 8-13 present data on stress levels, time to fail-

Table 1. Short-Time Tensile Properties of Glass-Reinforced Plastic Laminate Material #1 (Selectron 5003 Resin Plus 181-136 Fabric).

Test Period, Years		Tested Dry (73° F., 50% R.H.)			Tested Wet (73° F. in Water)		
		Modulus of Elasticity, 1,000 Psi.	Stress at Proportional Limit, Psi.	Maximum Stress, Psi.	Modulus of Elasticity, 1,000 Psi.	Stress at Proportional Limit, Psi.	Maximum Stress, Psi.
0		2,270	29,300	37,100	2,230	25,600	37,700
		2,075	30,700	37,800	2,440	27,500	41,900
		2,340	29,500	40,200	2,410	30,100	41,800
		2,330	21,800	40,900	2,290	25,600	38,400
		2,440	20,400	43,500	2,410	26,800	40,500
		2,320	30,800	42,400	2,430	24,800	39,700
	Average:	2,296	27,100	40,300	2,368	26,700	40,000
1		2,210	20,100	41,200	2,358	17,700	38,200
		2,175	18,700	34,700	2,602	13,400	38,500
		2,540	27,800	42,200	2,298	23,400	36,000
	Average:	2,308	22,200	39,400	2,416	18,200	37,600

Table 2. Short-Time Tensile Properties of Glass-Reinforced Plastic Laminate Material #2. (Selectron 5003 Resin Plus 1½-Oz. Mat).

Test Period, Years		Tested Dry (73° F., 50% R.H.)			Tested Wet (73° F. in Water)		
		Modulus of Elasticity, 1,000 Psi.	Stress at Proportional Limit, Psi.	Maximum Stress, Psi.	Modulus of Elasticity, 1,000 Psi.	Stress at Proportional Limit, Psi.	Maximum Stress, Psi.
0		823	—	7,230	841	3,490	7,600
		1,175	5,280	8,260	790	3,780	7,560
		1,127	4,450	8,460	875	3,500	7,100
		1,195	5,250	9,200	897	3,920	8,910
		1,051	4,790	9,410	892	3,990	10,100
		1,077	4,850	8,450	—	—	—
	Average:	1,075	4,920	8,500	859	3,740	8,250
1		1,426	3,640	10,690			
		1,163	3,810	9,700			
		1,422	8,320	13,440			
	Average:	1,337	5,260	11,270			

Table 3. Short-Time Tensile Properties of Glass-Reinforced Plastic Laminate Material #4. (Epon 828 Resin Plus 181 Glass Fabric, Volan A Finish).

	Tested Dry (73° F., 50% R.H.)			Tested Wet (73° F. in Water)		
	Modulus of Elasticity, 1,000 Psi.	Stress at Proportional Limit, Psi.	Maximum Stress, Psi.	Modulus of Elasticity, 1,000 Psi.	Stress at Proportional Limit, Psi.	Maximum Stress, Psi.
	3,110	15,400	52,000	3,000	13,640	51,450
	3,060	17,300	55,200	3,060	16,800	50,400
	3,240	12,600	59,200	2,800	17,250	52,400
	3,085	15,400	53,800	2,780	17,100	52,300
	2,930	16,700	50,100	3,060	15,900	53,000
Average:	3,085	15,500	54,100	2,940	16,140	51,910

ure, and certain information, both observed and computed, relating to strain. The stress applied is shown in the first column, and is expressed as a percentage of the short-time ultimate in the second column. Times to failure for those specimens that have failed are shown in the third column. For those that have not failed, the period during which they sustained the applied stress, up to the time of preparation of this report, is shown in the fourth column.

The strains observed after various periods are given in columns 5-11 of Tables 8-13. Deflection and deformation data obtained from the specimens under test were

Table 4. Short-Time Flexure Properties of Glass-Reinforced Plastic Laminate Material #1 (Selectron 5003 Plus 181-136 Fabric).

Test Period, Years		Tested Dry (73° F., 50% R.H.) Modulus of Elasticity, 1,000 Psi.	Fiber Stress at Proportional Limit, Psi.	Modulus of Rupture Psi.	Tested Wet (73° F. in Water) Modulus of Elasticity, 1,000 Psi.	Fiber Stress at Proportional Limit, Psi.	Modulus of Rupture Psi.
0		2,825	24,900	55,600	2,915	27,700	52,200
		2,960	22,900	58,600	2,740	32,200	51,400
		3,060	28,100	53,800	2,810	27,800	49,200
		2,800	32,500	56,600	2,750	32,500	52,600
		2,670	31,200	52,400	2,800	33,600	52,200
		2,665	24,400	56,000	2,750	35,800	52,600
	Average:	2,830	27,200	55,500	2,794	31,600	51,700
1		3,109	25,100	68,200	2,570	36,500	49,200
		3,125	23,700	67,800	2,520	36,600	48,800
		3,110	22,000	67,600	2,700	35,200	50,000
	Average:	3,134	23,600	67,900	2,596	36,100	49,300

Table 5. Short-Time Flexure Properties of Glass-Reinforced Plastic Laminate Material #2. (Selectron 5003 Plus 1½-Oz. Mat).

	Tested Dry (73° F., 50% R.H.) Modulus of Elasticity, 1,000 Psi.	Fiber Stress at Proportional Limit, Psi.	Modulus of Rupture Psi.	Tested Wet (73° F. in Water) Modulus of Elasticity, 1,000 Psi.	Fiber Stress at Proportional Limit, Psi.	Modulus of Rupture Psi.
	1,110	12,400	17,000	915	11,480	16,300
	997	11,560	16,920	854	9,230	17,200
	1,032	11,850	19,750	923	7,620	13,800
	1,055	9,170	16,380	797	9,140	16,200
	1,104	10,550	18,150	850	8,750	14,430
	1,240	11,400	21,000	—	—	—
Average:	1,090	11,150	18,200	868	9,240	15,590
After 1 year						
	1,092	9,580	17,850	—	—	—
	1,092	8,720	17,450	—	—	—
	1,236	7,450	17,800	—	—	—
Average:	1,140	8,580	17,700	—	—	—

converted to strains in inches per inch and plotted on semi-logarithmic coordinates; that is, strains were plotted on a linear scale and time on a logarithmic scale. The values of strain at specific periods shown in Tables 8-13 were taken from smooth curves drawn through the points on the strain-time plot. The values in the remainder of the tables include strain at rupture, computed constants for a theoretical relationship discussed later, and strains computed from this relationship for comparison with observed strains.

Figure 8 shows the variation with applied stress of the ratio of strain at rupture to elastic strain. A comparison of computed and observed strains for material #1 is shown in Figure 9.

Discussion of Results

Effect of Aging

The effect of aging at standard conditions is not clear. In two cases, strength properties appear to have increased, while in two cases there was no apparent change. As expected, under-water exposure for a year reduced strength properties.

It is not feasible to modify the stress levels for long-time loading according to the effects of aging. Accordingly, no change in stress levels to reflect changes in properties is planned.

Stress-rupture

The fabric laminate (material #1) provides the most consistent data, while the data for the mat laminate (material #2) show a considerable amount of scatter. The data from specimens tested under water are at a distinctly lower strength level than data from specimens tested under standard conditions. For example, a 181-polyester specimen at 60% of short-time strength has endured 10,000 hours of loading without failure. In water for a comparable period, however, the stress level is at only 35%.

Table 6. Short-Time Flexure Properties of Glass-Reinforced Plastic Laminate Material #4. (Epon 828 Plus 181 Glass Fabric, Volan A Finish).

	Tested Dry (73° F., 50% R.H.)			Tested Wet (73° F. in Water)		
	Modulus of Elasticity, 1,000 Psi.	Fiber Stress at Proportional Limit, Psi.	Modulus of Rupture Psi.	Modulus of Elasticity, 1,000 Psi.	Fiber Stress at Proportional Limit, Psi.	Modulus of Rupture Psi.
	2,995	33,650	74,400	3,190	32,850	63,900
	3,040	29,500	69,800	3,070	37,600	68,900
	3,090	33,500	72,200	3,110	29,600	71,600
	3,110	31,550	71,400	3,120	26,700	68,500
	3,030	32,300	68,300	3,020	40,500	71,000
Average:	3,053	32,100	71,220	3,102	33,450	68,780

Creep

A strain-time relationship for those specimens that failed is presented in Tables 8-13 as the ratio of strain at failure (ϵ_R) to the strain at the beginning of the constant-stress period (ϵ_e). Theoretically, the strain at failure is infinite, but the values reported here are an extrapolation of the strain from the last observed reading to the final time. The values of the ϵ_R/ϵ_e ratio decrease with increases in stress, as shown in Figure 8 by a plot of the data from the glass fabric-reinforced plastic laminate (material #1).

Other strain-time relationships that may aid the plastics designer are also shown in the tables. Columns 14 and 15 present creepocity, which is the percentage increase in strain during some period. Two values for creepocity are shown: ϕ_1, which represents the increase in strain from zero time to 1,000 hours; and ϕ_2, the increase in strain from one hour to 100 hours.

Extensive creep testing, with mathematical evaluations, has been reported on metals and non-reinforced plastics. The current trend is toward finding constants that can be used in the activation energy theory for the solution of the strain rate, V, in inches per inch per second. Work on glass-reinforced plastics by Worley and Findley** is pointed toward that end. This report and

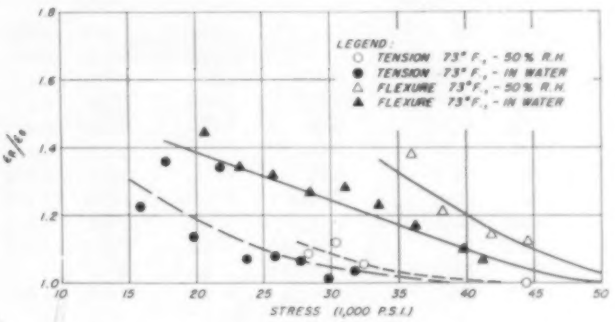


Fig. 8. Relationship of strain ratio to stress for laminate material #1 (Selectron 5003 polyester resin with 181-136 glass fabric).

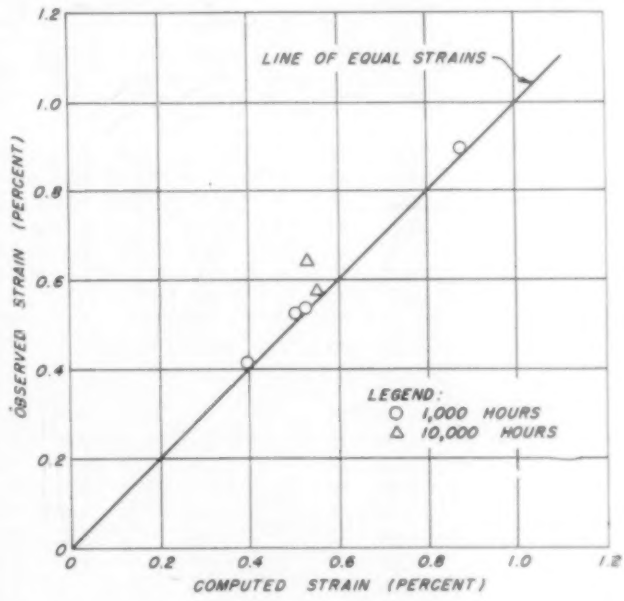


Fig. 9. Observed vs. computed strains for laminate material #1 in tension at 73° F. in water.

Table 7. Short-Time Tear Strengths of Laminates Used in Long-Term Tests.

Material	Shear Strength,* 1,000 Psi. At 73° F., 50% R.H.	At 73° F. in Water
(1) Selectron 5003 + 181-136 fabric	15.87	15.32
	16.75	14.18
	17.51	14.86
Average:	16.71	14.79
(2) Selectron 5003 + 1½-ounce mat	10.08	9.44
	10.89	9.62
	11.17	9.20
	12.50	10.20
	12.70	10.25
Average:	11.45	9.74
(4) Epon 828 + 181 glass fabric, Volan A finish	16.73	16.81
	18.26	17.47
	17.00	16.26
	18.35	17.87
	17.76	17.44
Average:	17.62	17.17

*Johnson double shear, force applied perpendicular to plane of laminate.

**Worley, W. J., and Findley, W. N.: "The Effect of Temperature on the Creep and Recovery of a Melamine-Glass Fabric Laminate." Pp. 1399-1412 in "ASTM Proceedings," Vol. 50 American Society for Testing Materials, Philadelphia, Pa. (1950).

Table 8. Stress-Rupture and Creep Data From Long-Term Tensile Tests of Laminate Material #1 (Selectron 5003 Resin, 181-136 Fabric).

Applied Stress		Rupture Data		Observed Strain, %, at							
Load, 1,000 Psi.	% of Max. Load	Rupture Time, Hrs.	Current Duration Hrs.	0 Hr.	0.1 Hr.	1 Hr.	10 Hrs.	100 Hrs.	1,000 Hrs.	10,000 Hrs.	Rupture ϵ_R, %
				Tested at 73° F. and 50% Relative Humidity							
16.1	40	—	10,000	0.801	0.819	0.829	0.842	0.868	0.892	0.913	—
18.2	45	—	10,000	0.829	0.840	0.852	0.874	0.900	0.930	0.962	—
20.2	50	—	10,000	0.724	0.736	0.751	0.774	0.798	0.825	0.850	—
22.2	55	—	10,000	0.815	0.822	0.841	0.868	0.897	0.930	1.052	—
24.2	60	—	10,000	1.033	1.044	1.073	1.102	1.130	1.170	1.206	—
26.2	65	—	10,000	0.977	0.985	1.005	1.032	1.062	1.097	1.133	—
28.2	70	40*	—	1.216	1.240	1.266	1.298	—	—	—	1.322
30.3	75	192	—	1.332	1.347	1.374	1.422	1.478	—	—	1.492
32.3	80	1.9	—	1.468	1.489	1.531	—	—	—	—	1.545
				Tested at 73° F. in Water							
9.22	25	—	6,600	0.341	0.352	0.360	0.370	0.385	0.415	—	—
11.90	30	—	10,000	0.443	0.451	0.464	0.480	0.504	0.537	0.573	—
13.87	35	—	10,000	0.426	0.437	0.448	0.464	0.486	0.522	0.646	—
15.85	40	3,628	—	0.760	0.775	0.792	0.814	0.848	0.894	—	0.931
17.85	45	346	—	0.860	0.871	0.885	0.908	0.951	—	—	1.170
19.85	50	454	—	0.865	0.876	0.890	0.912	0.948	—	—	0.985
21.80	55	264	—	0.896	0.916	0.940	0.962	1.010	—	—	1.200
23.80	60	4.2	—	1.090	1.105	1.135	—	—	—	—	1.167
25.80	65	14.0	—	0.980	0.996	1.015	1.051	—	—	—	1.055
27.80	70	3.20	—	1.210	1.225	1.262	—	—	—	—	1.291
29.75	75	0.08	—	1.147	—	—	—	—	—	—	1.164
31.70	80	0.25	—	1.451	1.476	—	—	—	—	—	1.503

Applied Stress		Computed Relationships					Strain, %, at		Theoretical Constants, %	
Load, 1,000 Psi.	% of Max. Load	Ratio ϵ_R/ϵ_0, %	Creepocity, % $\phi 1$	$\phi 2$	ϵ_0 %	n	1,000 Hrs.	10,000 Hrs.	ϵ_0	ϵ_∞
16.1	40	—	11.35	4.70	0.415	0.0195	0.890	0.912	0.698	0.371
18.2	45	—	12.20	5.62	0.426	0.0230	0.926	0.953	0.788	0.419
20.2	50	—	13.95	6.25	0.375	0.0256	0.822	0.850	0.875	0.465
22.2	55	—	14.10	6.66	0.420	0.0271	0.926	0.960	0.962	0.510
24.2	60	—	13.20	5.33	0.536	0.0220	1.160	1.193	1.048	0.556
26.2	65	—	12.26	5.67	0.502	0.0233	1.091	1.124	1.135	0.602
28.2	70	1.086	—	—	0.633	—	—	—	1.222	0.646
30.3	75	1.120	—	7.57	0.687	0.0307	—	—	1.330	0.702
32.3	80	1.052	—	—	0.766	—	—	—	1.370	0.724
9.22	25	—	21.7	6.94	0.180	0.0282	0.399	0.414	0.390	0.207
11.90	30	—	21.2	8.62	0.232	0.0348	0.527	0.552	0.503	0.267
13.87	35	—	22.5	8.40	0.224	0.0341	0.506	0.530	0.586	0.311
15.85	40	1.225	17.6	7.08	0.396	0.0287	0.878	—	0.670	0.355
17.85	45	1.360	—	7.46	0.442	0.0302	—	—	0.754	0.400
19.85	50	1.138	—	6.52	0.445	0.0265	—	—	0.838	0.444
21.80	55	1.340	—	7.45	0.470	0.032	—	—	0.922	0.489
23.80	60	1.070	—	—	0.567	—	—	—	1.005	0.532
25.80	65	1.078	—	—	0.507	—	—	—	1.090	0.577
27.80	70	1.067	—	—	0.631	—	—	—	1.175	0.622
29.75	75	1.012	—	—	—	—	—	—	—	—
31.70	80	1.035	—	—	—	—	—	—	—	—

Table 9. Stress-Rupture and Creep Data From Long-Term Flexure Tests of Laminate Material #1 (Selectron 5003 Resin, 181-136 Fabric).

Applied Stress		Rupture Data		Observed Strain, %, at						
Load, 1,000 Psi.	% of Max. Load	Rupture Time, Hrs.	Current Duration Hrs.	0 Hr.	0.1 Hr.	1 Hr.	10 Hrs.	100 Hrs.	1,000 Hrs.	10,000 Hrs.
				Tested at 73° F. and 50% Relative Humidity						
22.2	40	—	12,000	0.690	0.705	0.729	0.761	0.823	0.904	0.997
25.0	45	—	11,000	0.843	0.858	0.883	0.913	0.964	1.048	1.178
27.7	50	—	12,000	0.968	0.988	1.018	1.058	1.148	1.278	1.468
29.2	52½	—	11,000	0.971	0.997	1.026	1.075	1.141	1.257	1.446
30.6	55	—	12,000	1.076	1.091	1.112	1.168	1.264	1.426	1.626
33.3	60	—	12,000	1.111	1.120	1.163	1.222	1.305	1.406	1.601
36.1	65	1,355	—	1.244	1.264	1.306	1.371	1.491	1.676	—
38.2	70	51.9	—	1.440	1.468	1.514	1.614	—	—	—
41.6	75	18.7	—	1.474	1.506	1.557	1.659	—	—	—
44.4	80	2.2	—	1.630	1.639	1.687	—	—	—	—
				Tested at 73° F. in Water						
15.5	30	—	11,000	0.553	0.573	0.598	0.629	0.678	0.770	0.943
18.1	35	—	11,000	0.593	0.610	0.633	0.663	0.707	0.790	0.925
20.6	40	5,947	—	0.908	0.931	0.958	0.998	1.059	1.172	—
23.2	45	1,567	—	0.878	0.903	0.930	0.968	1.018	1.108	—
25.8	50	393	—	1.011	1.040	1.086	1.155	1.258	—	—
28.4	55	180	—	1.228	1.248	1.286	1.368	1.483	—	—
31.1	60	56.3	—	1.208	1.234	1.282	1.391	—	—	—
33.6	65	29.6	—	1.154	1.185	1.239	1.347	—	—	—
36.2	70	5.1	—	1.342	1.374	1.432	—	—	—	—
38.8	75	0.93	—	1.454	1.495	—	—	—	—	—
41.2	80	0.14	—	1.806	1.922	—	—	—	—	—

Applied Stress			Computed Relationships		
Load, 1,000 Psi.	% of Max. Load	Rupture ϵ_R, %	Ratio ϵ_R/ϵ_o, %	Creepocity, % $\phi 1$	$\phi 2$
22.2	40	—	—	31.0	12.90
25.0	45	—	—	24.3	9.17
27.7	50	—	—	32.0	12.76
29.2	52½	—	—	29.5	11.20
30.6	55	—	—	32.5	13.67
33.3	60	—	—	26.6	12.21
36.1	65	1.719	1.382	34.8	14.16
38.2	70	1.750	1.215	—	—
41.6	75	1.689	1.145	—	—
44.4	80	1.830	1.122	—	—
15.5	30	—	—	39.2	13.38
18.1	35	—	—	33.3	11.70
20.6	40	1.305	1.438	29.1	10.55
23.2	45	1.178	1.341	26.2	9.47
25.8	50	1.335	1.321	—	15.84
28.4	55	1.553	1.265	—	15.31
31.1	60	1.548	1.281	—	—
33.6	65	1.417	1.228	—	—
36.2	70	1.574	1.172	—	—
38.8	75	1.600	1.100	—	—
41.2	80	1.936	1.071	—	—

Table 10. Stress-Rupture and Creep Data from Long-Term Tensile Tests of Laminate Material #2 (Selectron 5003 Resin, 1½ Oz. Mat)

Applied Stress		Rupture Data		Observed Strain, %, at							Computed Relationships						Strain, %, at		Theoretical Constants, %	
Load, 1,000 Psi.	% of Max. Load	Rupture Time, Hrs.	Current Duration Hrs.	0 Hr.	0.1 Hr.	1 Hr.	10 Hrs.	100 Hrs.	1,000 Hrs.	10,000 Hrs.	Rupture ϵ_R, %	Ratio ϵ_R/ϵ_o, %	Creepocity, % ø1	Creepocity, % ø2	ϵ_o %	n	1,000 Hrs.	10,000 Hrs.	ϵ_o	ϵ_{oc}
				Tested at 73° F. and 50% Relative Humidity																
2.98	35	—	*	0.163	0.173	0.181	0.198	0.228	0.278	(1)	—	—	70.5	26.0	0.090	0.0909	0.260	—	0.277	0.146
3.40	40	—	6,500	0.285	0.299	0.317	0.340	0.374	0.443	—	—	—	55.5	18.0	0.158	0.0667	0.409	—	0.316	0.167
3.82	45	—	*	0.284	0.300	0.319	0.347	0.389	0.450	(1)	—	—	58.4	21.9	0.159	0.0789	0.433	—	0.355	0.188
4.25	50	—	6,500	0.283	0.300	0.318	0.331	0.374	0.427	—	—	—	50.7	17.6	0.159	0.0655	0.409	—	0.395	0.209
4.67	55	—	6,500	0.425	0.436	0.461	0.490	0.530	0.591	—	—	—	39.0	14.9	0.230	0.0566	0.570	—	0.435	0.230
5.10	60	—	6,500	0.449	0.482	0.520	0.569	0.641	0.756	—	—	—	68.4	23.2	0.260	0.0827	0.720	—	0.474	0.251
5.53	65	—	2,500	0.529	0.559	0.589	0.634	0.685	0.744	—	—	—	40.7	16.3	0.294	0.0616	0.742	—	0.514	0.271
5.95	70	74	—	0.578	0.596	0.626	0.662	—	—	—	0.696	1.205	—	—	0.313	—	—	—	0.554	0.293
6.38	75	—	6,500	0.492	0.502	0.530	0.566	0.618	0.687	—	—	—	39.6	16.6	0.265	0.0622	0.672	—	0.620	0.327
6.80	80	—	2,500	0.544	0.579	0.594	0.669	0.694	0.800	—	—	—	47.0	16.9	0.297	0.0633	0.756	—	0.680	0.360
7.23	85	0.01	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

* Test discontinued.

Table 11. Stress-Rupture and Creep Data from Long-Term Flexure Tests of Laminate Material #2 (Selectron 5003 Resin, 1½ Oz. Mat)

Applied Stress		Rupture Data		Observed Strain, %, at							Computed Relationships			
Load, 1,000 Psi.	% of Max. Load	Rupture Time, Hrs.	Current Duration Hrs.	0 Hr.	0.1 Hr.	1 Hr.	10 Hrs.	100 Hrs.	1,000 Hrs.	10,000 Hrs.	Rupture ϵ_R, %	Ratio ϵ_R/ϵ_o, %	Creepocity, % ø1	Creepocity, % ø2
				Tested at 73° F. and 50% Relative Humidity										
8.19	45	—	6,000	0.778	0.838	0.877	0.931	1.015	1.158	—	—	—	48.8	15.7
9.10	50	—	6,000	0.830	0.904	0.941	0.994	1.074	1.180	—	—	—	42.2	14.1
10.01	55	—	6,000	1.151	1.211	1.264	1.337	1.446	1.601	—	—	—	39.1	14.4
10.92	60	16	—	1.222	1.342	1.388	1.408	—	—	—	1.412	1.157	—	—
11.83	65	258	—	1.238	1.388	1.498	1.661	1.928	—	—	2.188	1.766	—	28.7
12.74	70	—	6,000	1.144	1.194	1.265	1.346	1.466	1.684	—	—	—	47.3	15.9
13.65	75	0.20	—	1.454	1.770	—	—	—	—	—	1.854	1.275	—	—
13.65	75	0.30	—	1.465	1.615	—	—	—	—	—	1.642	1.121	—	—
14.56	80	88	—	1.340	1.450	1.434	1.660	—	—	—	1.810	1.350	—	—
				Tested at 73° F. in Water										
10.12	65	—	2,000	1.165	1.265	1.350	1.475	1.640	1.825	—	—	—	56.6	21.5
10.90	70	—	2,000	1.120	1.220	1.320	1.452	1.657	1.920	—	—	—	71.4	25.5
11.69	75	0.26	—	1.600	1.844	—	—	—	—	—	1.901	1.189	—	—
12.44	80	0.65	—	1.830	2.025	—	—	—	—	—	2.187	1.195	—	—

Table 12. Stress-Rupture and Creep Data from Long-Term Tension Tests of Laminate Material #4 (Epon 828 Resin, 181 Glass Fabric, Volan A Finish)

Applied Stress		Rupture Data		Observed Strain, %, at							Computed Relationships								Theoretical Constants, %	
Load, 1,000 Psi.	% of Max. Load	Rupture Time, Hrs.	Current Duration Hrs.	0 Hr.	0.1 Hr.	1 Hr.	10 Hrs.	100 Hrs.	1,000 Hrs.	10,000 Hrs.	Rupture ϵ_R, %	Ratio ϵ_R/ϵ_o, %	Creepocity, % $\phi 1$	Creepocity, % $\phi 2$	ϵ_o, %	n	Strain, %, at 1,000 Hrs.	Strain, %, at 10,000 Hrs.	ϵ_e	ϵ_{oc}
Tested at 73° F. and 50% Relative Humidity																				
37.9	70	—	2,600	1.096	1.122	1.133	1.152	1.183	1.261	—	—	—	15.05	4.42	0.566	0.0184	1.208	—	1.360	0.720
40.6	75	70	—	1.320	1.337	1.350	1.372	—	—	—	1.395	1.058	—	—	0.675	—	—	—	—	—
43.3	80	1.3	—	1.490	1.536	1.562	—	—	—	—	1.564	1.050	—	—	0.781	—	—	—	—	—
Tested at 73° F. in Water																				
31.1	60	950	—	0.988	1.022	1.040	1.068	1.131	—	—	1.228	1.245	—	8.75	0.520	0.0350	—	—	1.150	0.607
33.7	65	—	1,500	0.884	0.901	0.920	0.950	1.009	1.104	—	—	—	24.89	9.68	0.460	0.0384	1.060	—	1.250	0.660
36.4	70	360	—	1.140	1.175	1.192	1.250	1.365	—	—	1.525	1.338	—	14.51	0.596	0.0553	—	—	1.350	0.713
38.9	75	3.4	—	1.260	1.273	1.310	—	—	—	—	1.335	1.060	—	—	0.655	—	—	—	1.450	0.765
41.5	80	0.07	—	1.450	—	—	—	—	—	—	1.457	1.005	—	—	—	—	—	—	1.550	0.819

Table 13. Stress-Rupture and Creep Data from Long-Term Flexure Tests of Laminate Material #4 (Epon 828 Resin, 181 Glass Fabric, Volan A Finish)

Applied Stress		Rupture Data		Observed Strain, %, at							Computed Relationships			
Load, 1,000 Psi.	% of Max. Load	Rupture Time, Hrs.	Current Duration Hrs.	0 Hr.	0.1 Hr.	1 Hr.	10 Hrs.	100 Hrs.	1,000 Hrs.	10,000 Hrs.	Rupture ϵ_R, %	Ratio ϵ_R/ϵ_o, %	Creepocity, % $\phi 1$	Creepocity, % $\phi 2$
Tested at 73° F. and 50% Relative Humidity														
46.3	65	1,285	—	2.090	2.125	2.163	2.211	2.278	2.375	—	2.385	1.140	13.64	5.33
49.9	70	29	—	2.100	2.140	2.165	2.206	—	—	—	2.234	1.064	—	—
53.4	75	478	—	2.330	2.375	2.404	2.442	2.518	—	—	2.575	1.105	—	4.74
58.6	82	1.7	—	2.340	2.430	2.490	—	—	—	—	2.505	1.070	—	—
61.0	86	0.05	—	1.500	—	—	—	—	—	—	1.540	1.026	—	—
Tested at 73° F. in Water														
37.80	55	—	2,000	1.340	1.380	1.406	1.450	1.518	1.645	—	—	—	22.75	7.96
41.25	60	1,602	—	1.590	1.635	1.667	1.716	1.795	1.945	—	1.990	1.250	22.30	7.68
44.65	65	80	—	1.670	1.728	1.760	1.825	—	—	—	1.915	1.146	—	—
48.10	70	51.5	—	1.790	1.843	1.879	1.926	—	—	—	1.968	1.098	—	—
51.55	75	15.5	—	1.880	1.956	2.034	2.122	—	—	—	2.134	1.136	—	—
54.95	80	0.22	—	2.042	2.115	—	—	—	—	—	2.292	1.122	—	—
58.40	85	0.07	—	2.059	—	—	—	—	—	—	2.100	1.021	—	—

Table 14. Stress-Rupture Data in Shear (Johnson Double Shear) of Laminates.

Material		At 73° F., 50% R.H.			At 73° F. in Water		
		Stress Level			Stress Level		
Resin	Fabric	at 1,000 Psi.	% of Static Ultimate	Time to Rupture, Hrs.	at 1,000 Hrs.	% of Static Ultimate	Time to Rupture, Hrs.
Selectron 5003	181-136	16.71	100	0	14.79	100	0
		15.04	90	0.189	11.09	75	12.8
		14.20	85	0.135	10.35	70	26.5
		13.37	80	10.20	9.61	65	481.3
		12.53	75	1.70	—	—	—
		12.53	75	0.90	—	—	—
Selectron 5003	1½-oz. mat	11.45	100	0	9.74	100	0
		10.30	90	0.019	8.28	85	0.34
		9.73	85	2.26	7.79	80	0.26
		9.16	80	6.10	7.79	80	1.33
		8.81	77	28.5	7.31	75	8.70
		8.58	75	4.75	6.82	70	2.73
		8.58	75	13.25	6.33	65	15.2
		8.36	73	49.0	—	—	—
Epon 828	181 glass fabric, Volan A Finish	17.62	100	0	17.17	100	0
		15.86	90	0.025	15.45	90	0.034
		14.98	85	0.27	14.59	85	1.65
		14.10	80	0.80	13.74	80	0.10
		13.22	75	123.1	12.88	75	8.70
		—	—	—	12.02	70	347.0

others indicate that certain factors in the theory may be used as a means of comparing creep properties of materials.

The tensile creep behavior of a material may be expressed with reasonable accuracy by an equation of the form:

$$\epsilon = \epsilon_o (1 + t^n) \qquad (1)$$

where ϵ is the total strain in inches per inch of a material under constant stress; ϵ_o is some initial strain marking the beginning of this function; t is time in hours; and n is a dimensionless exponent. Constants in this equation and strain rates from the differential

$$d\epsilon/dt = \epsilon_o n t^n - 1 \qquad (2)$$

of this equation may be used to compare materials. Worley and Findley's work indicates that this relationship does apply, that n is dependent on the material, and that ϵ_o is a function of the applied steady stress for any given material.

Values of the constant n in equation (1) have been computed and are shown in Tables 8, 10, and 12. The values of n have been computed from the observed total strains at $t_1 = 1$ hour and $t_2 = 100$ hours from the relationship

$$n = \frac{\log (\phi_2/50 + 1)}{\log t_2} \qquad (3)$$

where ϕ_2 is the observed creepocity between one-hour and 100-hour durations, thus:

$$\phi_2 = \frac{\epsilon_2 - \epsilon_1}{\epsilon_1} \times 100 \qquad (4)$$

The values of n for a given material under a given condition were so nearly equal for all stress levels, as revealed by plots of $\epsilon - \epsilon_o = \epsilon_o t^n$ on log coordinates, that they were averaged. These average values of n are as follows:

Material	Dry	Wet
(1) Polyester+fabric	0.0245	0.0304
(2) Polyester+mat	0.0697	—
(3) Epon+fabric	0.0184	0.0429

Values of the constant ϵ_o in equation (1) were computed from the observed total strains at one hour at the various applied stress levels. Thus, in equation (1) for time t at 1 hour, and observed strain ϵ_1 at 1 hour,

$$\epsilon_1 = \epsilon_o (1 + 1^n)$$
$$\epsilon_1 = 2\epsilon_o$$
$$\text{and } \epsilon_o = \frac{\epsilon_1}{2} \qquad (5)$$

The values of n for a given material under a given one hour are given in Tables 8, 10, and 12.

The current usefulness of these constants can be demonstrated by the accuracy with which the strain-time relationship may be projected. It should be noted that the values of n were computed for creepocity between one and 100 hours, and that the creep study is to span five years (43,800 hours). Total strains at 1,000 and 10,000 hours were computed for comparison with observed strains at these durations. The computed strains, using constants ϵ_o and n are given in Tables 8, 10, and 12 for 1,000 and 10,000 hours.

These computed strains are compared graphically in Figure 9, and show that the observed strains tend to be

(*Continued on page 820*)

Maintenance Must Be Planned

Ten pointers to use in setting up an equipment maintenance program for a plastics plant

ERNEST W. FAIR, *Field Editor for Business and Industrial Magazines*

A DAB of oil here, a twist of a wrench there, a tightening of a belt, adjustment of tension now and then; all of these constitute maintenance of a sort—the wrong sort. All are haphazard. Good maintenance is never haphazard, but is planned and carefully programmed in even the smallest plastics plant. Without such planning and programming, equipment life is wasted, production dollars are allowed to fritter away, and costs rise on every job turned out in the plant.

Maintenance planning belongs in the smallest plastics plant. It should be set up and regulated to fit the squipment and schedules of the specific plant, for no two plants are exactly alike. Literal adoption of a tight schedule, as used by one plant, may be utterly useless and wasteful in another.

There is a basic skeleton around which each such maintenance program should be built. With this skeleton, any plastics plant official can set up such a program of his own. It suggests the 10 individual points pertinent to his own installation that should be a part of his tailor-made maintenance plan or program. These points are as follows:

(1) Responsibility. Determining just who will be responsible for application of the program after it has been drawn up is essential. Without fixed and definite responsibility on one individual in the organization, the program itself will falter no matter how good the plan. In turn, there must be a definite degree of responsibility assigned to every man or woman on the plant staff who uses any equipment therein. They should know and understand the general maintenance plan and, in particular, their own part in carrying it out.

(2) Financial support of the plan is vital. The program should always take care of this phase of maintenance, and the sums alloted should be flexible enough to take care of unusual conditions and circumstances.

Approval of management may well be required under the program where estimated cost of labor and materials exceeds a certain amount (usually about $25) and, thus, a degree of control retained over the costs of the program. Minor expenditures can best be left to people in the plant concerned with maintenance in order to avoid useless (and endless) record-keeping chores on the part of the plant official in charge of the maintenance program.

It is extremely difficult to set up a fixed sum for

maintenance since breakdowns, unforeseen high production schedules, and other factors may cause wear and tear on plant equipment well ahead of schedule. The budget set up by the plant management should, therefore, have a degree of flexibility which will allow for the unforeseen.

(3) Maintenance records are vital to any good program. They should be set up at the very start and maintained as religiously as are the records on receipts and expenditures in the front office. The best procedure is to set up an individual card record for each piece of major equipment in the plant, detailing the maintenance history of that piece of equipment. Such records usually are kept in the office of the individual placed in charge of the maintenance program.

(4) Work schedules for coming periods should be part of the program. These should be made up on three classes of work: (a) jobs which can be definitely planned well ahead, such as inspections and routine jobs; (b) jobs which may vary with conditions, but nevertheless must be fitted in at approximately scheduled times; and (c) jobs which must be done as emergencies arise. Flexibility in the master schedule is needed to handle the latter type of maintenance jobs.

(5) A good tickler file also is a vital part of any plant maintenance program. This should be arranged so as to present work orders and data on forthcoming jobs to be done. Such a file should show all such maintenance jobs that have been definitely scheduled for fixed future dates, with accompanying "check" spaces for initialing that the job has been done. A warning system is an aid in such a file. In this system, an additional card of another color is set up from 1-2 weeks before the scheduled date of the job so that any needed preliminary planning can be done and parts ordered in advance. In this way, everything can be ready for each routine maintenance job on the scheduled date.

(6) A daily work program is the next step in the schedule. This should be made out from the outline of work ahead, and also fitting in emergency jobs for which orders or requests have just been received. Without such records, maintenance easily becomes haphazard. With records of this type, even the minutest maintenance procedure acquires fixed standing and responsibility, and is certain to be handled properly at the right time.

(7) Maintenance materials requirements should be calculated at the time the program is set up. When this procedure is followed, control of cost of maintenance is much closer. This also assures that funds will be available for maintenance work as it arises, and that nothing need ever be "put off" because of lack of funds at any particular time. This latter procedure is one of the major sins of maintenance in many plants today. Each time needed maintenance is postponed for any reason whatsoever, the future life of that particular piece of equipment is shortened by every day that goes by without the proper maintenance work being done.

(8) Obtaining the proper information and data for correct maintenance is an important part of the program. A file of service and maintenance data, as supplied originally by the manufacturer of each piece of equipment, should be set up. Where these have been lost, replacements should be secured immediately. This data helps prevent mistakes in maintenance which can sometimes be as costly as complete absence of maintenance.

Such a file should also contain lubrication charts and other maintenance data from every possible source. This information should be kept available for not only routine maintenance procedures, but as a source of data when something unexpected arises and there is no available experience on the plant staff to handle that situation.

(9) Any good maintenance program allows for periodic training and instruction not only of the individual or individuals in charge of maintenance in the plant, but of every man and woman who uses any machine therein. The over-all job of good, low cost maintenance is always much more easily accomplished in a plant where everyone on the staff is maintenance conscious and kept that way through periodic maintenance demonstrations or discussions. The same attention that we give to safety in our plants today should apply to maintenance; the results are just as important.

(10) Time charts should be established for each machine in the plant. These should assure the plant management that each unit receives proper maintenance attention as frequently as needed. Such charts also have a big advantage in permitting scheduling of each individual maintenance jobs so that there are no periods of heavy maintenance load and others with relatively nothing to do.

—The End

Effect of Long-Term Loading on Glass Fiber-Reinforced Plastic Laminates

(*Continued from page 818*)

slightly larger than the computed strains. As more data become available, some adjustments of the constants may be necessary.

The value of ϵ_o depends on stress, so that in order to predict creep characteristics at a stress other than one for which data are available, some means must be found of estimating the value of ϵ_o corresponding to that stress. Findley# showed that for plastics reinforced with materials other than glass:

$$\epsilon_o = C_2(e^{k\sigma} - 1) \qquad (6)$$

where σ = stress and C_2 and k are constants. Data available to date are too limited and scattered to permit the use of this relation.

If it is assumed, however, that the strain at the beginning of creep time, t_e, is ϵ_e, from equation (1), we obtain:

$$\epsilon_o = \frac{\epsilon_e}{1 + t_e^n} \qquad (7)$$

The exact moment at which load is fully applied to the long-term specimen is difficult to determine, and values of ϵ_e and t_e are likely to be in error. If, however, it is assumed that the application of load to the long-term specimen is exactly the same as in the short-time test, the strain at the applied stress could be taken from the short-time stress-strain curve. For stresses below the proportional limit, the strain ϵ_e would be σ/ϵ.

#Findley, W. N., "Creep Characteristics of Plastics," Modern Plastics, 22, 4, 153 (Dec. 1944).

Then, if the theoretical strain- time curve based on equation (1) could be projected backward to this stress-strain value of ϵ_e, the corresponding time t_e would be determined. This procedure for the polyester-fabric laminate (material #1) indicated that t_e was about 0.01 hour (36 seconds), so that

$$\epsilon_o = \frac{\epsilon_e}{1+0.01^n} \qquad (8)$$

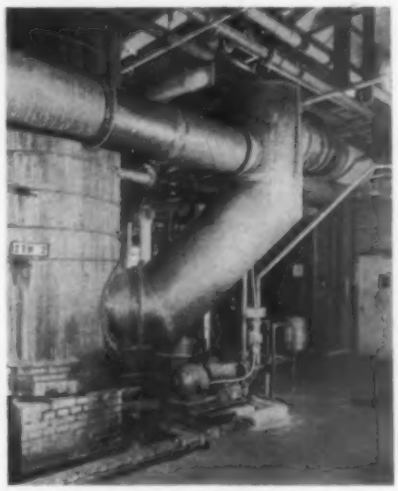
Values of ϵ_e obtained from the stress-strain curves are shown in Tables 8, 10, and 12, and values of ϵ_o computed from the above relationship are shown as ϵ_{oc}. In comparing these values of ϵ_{oc} with values of ϵ_o computed from $\epsilon_o = \frac{\epsilon^1}{2}$, some scatter is evident, but the agreement is reasonably good. Agreement is very poor for laminates made with the epoxy resin, however, and additional data and analyses are needed.

It is hoped that, as additional data become available, it will be possible to relate tensile creep data to flexural creep data. Since stresses will vary from point to point in the flexure specimen, data for solution of equation (1) for a variety of stresses will be needed, and procedures such as those discussed above will be needed to obtain the necessary constants.

Summary and Conclusions

The U. S. Forest Products Laboratory, in cooperation with the Bureau of Ships, Department of the Navy, is investigating the stress-rupture and creep characteristics of glass-fiber-reinforced plastic laminates typical of those used in shipboard applications. Four typical laminates are being tested in tension, flexure, and shear at 73° F. and 50% relative humidity, and at 73° F. in water, for periods up to five years to observe strains and time to failure.

Data obtained during the first year (that is, during some 10,000 hours) showed that the stress at rupture decreases with time; that the rate of decrease is greater in water than in air; and that the tensile strains appear to conform to the relationship, $\epsilon = \epsilon_o(1+t^n)$. Since more data will be forthcoming, exact relationships have not been established. —The End



Fiberglas-reinforced venting system in good condition after three years.

Reinforced-Plastic Venting Ducts

The service life of tanks, hoods, and exhaust ducts has been extended many times by Fiberglas-reinforced polyester systems engineered by duVerre, Inc., Buffalo, N. Y. The application potential for these systems is tremendous, as is evidenced by the fact that a single plant of a basic chemical producer has more than 750 mixing and processing tanks which must be hooded and vented. The cost of tank repair and replacement in this plant was in excess of $50,000 per year.

Stainless steel reactor fume ducts installed at a Niagara Falls chemical company showed corrosion in the welds shortly after installation, and gross failure within 60 days. Aluminum ducts required extensive repairs within several months, and complete failure occurred after 11 months. No sign of deterioration were noted with duVerre ducts after five months in service.

Still more impressive is the performance of the reinforced plastic ducts in a dye plant, where they were subjected to wet chlorine, hydrogen bromide, and hydrochloric acid in combination with organic solvents. No ill effects have been observed after three years of continuous duty.

Outstanding properties of these materials are corrosion resistance, structural strength, lightness of weight, and ability to be molded into complex shapes. The only applications where polyester systems are not recommended involve very high temperatures and/or strong alkalis. This is actually no drawback, since ordinary steel is usually satisfactory under these conditions. —The End

ERRATUM: The article on "Spread Coating Techniques" in the November issue was indicated to be in two parts. This was an error; original plans called for two-part publication, but a last-minute change permitted use of the complete article in November.

News of the Societies

ASME Rubber & Plastics Division Meeting

The Rubber and Plastics Division of the American Society of Mechanical Engineers held a one-day technical meeting on November 29 in conjunction with the annual meeting of the Society in New York City on November 25-30. Some 100 members and guests attended the Division meeting at the Statler Hotel. The meeting consisted of a morning session on plastics, at which four papers were presented, and an afternoon session devoted to rubber and also comprising four papers.

C. H. Adams, Monsanto Chemical Co., acted as chairman of the plastics session, with Murray Longstreth, Dow Chemical Co., as vice chairman. Abstracts of the papers presented at this session follow:

"The Fundamental Mechanics of Reinforced Plastics," J. O. Outwater, Jr., University of Vermont. The speaker presented an interesting theoretical approach to a better understanding of reinforced plastics behavior. It was suggested that the governing factors are the pressures exerted on the fibers by polymerization of the resin, and the coefficient of friction between the fibers and the resin. A mathematical equation was proposed for this relationship, and the hypothesis permits evaluation of fiber-resin structure behavior under varying stresses.

"Penton—A New Chlorine-Containing Polymer," E. W. Cronin, Hercules Powder Co. The polymer is a chlorine-containing polyether having a unit structure similar to that of pentaerythrital, and is said to have a unique combination of properties. These are high fabrication temperature (up to 550° F.); good melt flow and good moldability; low mold shrinkage and close mold tolerances; minimum strains in moldings; high dimensional stability and low water absorption; good chemical resistance; and good electrical properties over a wide temperature range.

"Electrical Effects Accompanying a Stick-Slip Phenomenon of Sliding Metals on Plastics and Lubricated Surfaces," S. M. Skinner, Case Institute of Technology, Joseph Gaynor, General Electric Co., and G. W. Sohl, B. F. Goodrich Chemical Co. This paper dealt with the electrical transient potentials which accompany stick-slip motion in boundary lubricating, resulting from an instantaneous frictional drag in the movement of metallic objects in contact with plastic materials. The characteristics of the electrical discharge created from such contact would favor a charge-discharge mechanism rather than a thermoelectrical potential or a dielectric breakdown mechanism.

"A Review of Developments in Plastics Engineering, 1955-56," Bryce Maxwell, Princeton University. This annual review paper noted that plastic materials developments have consisted mainly of improvements in older materials rather than the development of new plastics. Greatest improvements have occurred in epoxy isocyanate, polyester, nylon, and polyethylene resins. New fabrication techniques have been developed, particularly in injection and extrusion methods. Engineering research studies have added to methods for evaluating plastic materials, and analysis from heat distortion and melt viscosity measurements has thrown some light on basic resin structure. Continued emphasis is being placed on fundamental engineering studies of problems underlying fabrication and application of plastic materials.

The afternoon session on rubber had Sherman Doner, Manhattan Rubber Division, Raybestos-Manhattan, Inc., as chairman, and W. M. Petry, Akron University, as vice chairman. The following four papers were presented at this session:

"Polymer Properties Involved in Process Equipment Design," H. J. Karam, Dow Chemical Co.

"Roll Bending Applied to Rubber and Plastics Calenders," R. C. Seanor, Adamson-United Co.

"High Horsepower Banbury Mixer," R. N. Comes, Farrel-Birmingham Co.

"Recent Developments in the Field of Mixer Extruders," J. F. Drew, National Rubber Machinery Co.

SPE Eastern New England and SPI Providence Joint Meeting

A joint meeting of SPE's Eastern New England Section and the Providence Chapter of SPI was held on September 27, at the Hampton Court Hotel, Brookline, Mass. Approximately 120 members and guests were in attendance.

Richard B. Greene, Barrett Division, Allied Chemical & Dye Corp., addressed the group on "Polyurethanes—The New Old Resins," tracing the development of these materials down to the present day. Foamed-in-place applications furnish the large market for polyurethanes, according to Dr. Greene, especially in boats, trailers, and mattresses. While coatings offer superior properties, they have practically no shelf life. In addition, costs are almost prohibitive. Molding applications have shown desirable impact resistance, [illegible] here, too, price is an important factor.

"Cellular Vinyls" were outlined by W[illegible] liam G. McLain, B. F. Goodrich C[illegible] who pointed out their advantages in ter[illegible] of cost, properties, and ease of operati[illegible] Vinyl foams are formed through the u[illegible] of a blowing agent, which releases nitrog[illegible] gas on heating to the decomposition poi[illegible] Foams may be flexible or rigid, have op[illegible] or closed cell structure, and may [illegible] obtained in a wide range of densiti[illegible] Height or thickness limit is three inch[illegible] using conventional heating; six inch[illegible] using R. F. heating in the fusion stage on[illegible]

SPE New York Section

Approximately 85 members and gues[illegible] attended the October 17 meeting of SPE New York Section, which was held at th[illegible] Gotham Hotel in New York City. Tw[illegible] speakers were featured: E. E. Merrill, Do[illegible] Chemical Co., who covered "New Varia[illegible] tions of General Purpose Styrene;" an[illegible] W. A. Ward, American Cyanamid Co[illegible] whose topic was "Reinforced Glass-Mela[illegible] mine Molding Material."

Mr. Merrill stated that few, if any, com[illegible] mercial injection molding machines ar[illegible] available to take advantage of the high flow characteristics and fast set-up of the new general-purpose styrenes. In addition, special steels must be found for building the proper molds. Thin-walled containers and packages will be molded on exceptionally short cycles, and the material must enter and fill the mold cavity within a fraction of a second. Over-all cycles will be less than five seconds. This will require entirely new concepts of mold and machine design.

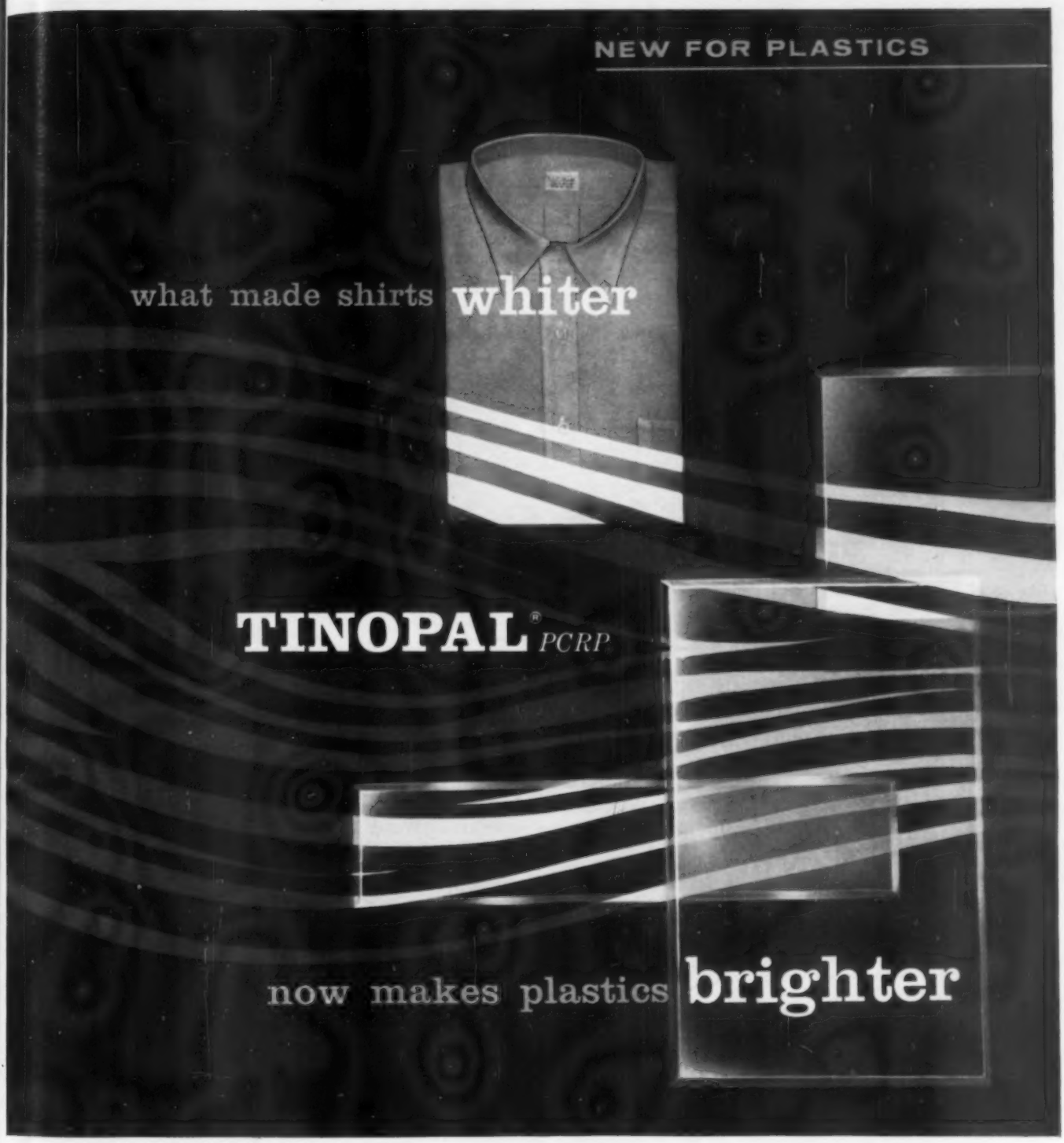
Mr. Ward described Cymel 3136, a general-purpose, glass-reinforced melamine molding material, which is now available in granular form. Featuring better than average impact strength, electrical properties, and moldability, the material has found myriads of electronic applications as well as use in switch housings and terminal blocks. The material is adapted to automatic preforming and high-frequency heating on both compression and transfer molds. Compound stability is good, and shrinkage characteristics are in the range of the lowest values associated with amino plastics.

Joint Meeting with Newark

Over 100 members and guests attended the joint meeting of SPE's New York and Newark Sections, which was held on November 21 at the Gotham Hotel in New York City. A two-part program was presented.

Bennett Nathanson, Monsanto Chemical Co., spoke on "High-Speed Automatic Molding, covering the first successful efforts by machinery manufacturers to build for specific markets such as packaging. Factors determining the speed and capabilities of machines were described as follows: ability to plasticize the required charge, time required for advancement of the plunger, and the weight of the shot in relation to the melt capabilities of the cylinder.

Many molders speed-up their cycles by de-rating their machines. Other methods in-



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clude the use of hot-runner dies, submarine gates, the three-plate die, and the runnerless type of molding employed by the newer, small machines. Advantages of hot-runner dies are the elimination of sprue and runner scrap, secondary plasticizing chamber, and the use of lower temperatures. Present-day machines can be made more economical by increasing clamp and injection speeds, and increasing the volume of fluid on the ram through the use of larger pumps.

"1957 Labor Relations" were described by Emil Lindahl, president of Nassau-Suffolk County CIO Council. The various aspects of collective bargaining were covered, including the best methods of dealing with legitimately-formed unions. A majority of the discussion covered grievances, both on the part of the employer and the employees.

Society of Rheology Meets

The annual meeting of the Society of Rheology was held at Mellon Institute, Pittsburgh, Pa., on November 7-9. The technical program was divided into five half-day sessions, and papers were presented on the following topics: adhesives and absorbed polymer layers, measurements of viscosity and normal stress, effects of entrapped hydrogen on the mechanical properties of metals, and the viscoelastic properties of liquids and polymer solutions.

At the Social Hour Smoker on November 8, Arthur V. Tobolsky, Princeton University, was presented the Bingham Medal of the Society. The award was made for Professor Tobolsky's research achievements in the fields of elastoviscous properties of polymeric materials and the kinetics of polymerization reactions.

ACS Plastics Division Elects

J. Kenneth Carver, Monsanto Chemical Co., has been elected 1957 chairman of the Division of Paint, Plastics, and Printing Ink Chemistry, American Chemical Society Professor L. R. Brantley, Occidental College, was chosen chairman-elect, and A. L. Alexander, Naval Research Laboratory, was named vice chairman. The new secretary-treasurer is E. R. Mueller, Battelle Memorial Institute. Named to represent the Division on the ACS Council was J. K. Wise, U. S. Gypsum Co., with A. K. Doolittle, Carbide & Carbon Chemicals Co., as alternate councilor.

Mr. Carver succeeds Dr. Russell B. Akin, E. I. du Pont de Nemours & Co., as Division chairman. Mr. Carver has been with Monsanto since 1938, except for a two-year association with General Mills, Inc. He is an authority on plasticizers, and holds several patents. In addition to ACS, Mr. Carver is a member of ASTM, Alpha Chi Sigma, and Mu Tau Pi.

ASTM Forms New Subcommittee

The American Society for Testing Materials has formed a new subcommittee to study the effects of nuclear and high-energy radiation on the properties of plastics and electrical insulation. At the first meeting of the group in St. Louis, Mo., on October 16, D. S. Ballantine, Brookhaven National Laboratory, was named chairman.

At that time, it was brought out that existing data in the field of radiation was confusing due to the lack of standardization. Different sources of radiation are used, different methods are used to determine and express the dosages received, irradiations are done under different conditions, and different test methods are used to evaluate results.

Prime objectives of the new subcommittee are to establish standard methods of irradiation and standard methods of determining the effects of irradiation on the physical and chemical properties of plastics. The subcommittee is sponsored jointly by ASTM Committees D-20 on Plastics and D-9 on Electrical Insulating Materials. Sections will work in the following areas: nomenclature and definitions, dosimetry, correlation of radiation sources, total dosage and dose-rate effects, and post irradiation effects.

Plans UET Engineering Center

United Engineering Trustees, Inc., a corporate agency of the four major engineering societies in the United States, has contracted for preliminary architectural plans on a new engineering center in mid-Manhattan, New York City. Announcement coincided with the reelection of Walter J. Barrett, New Jersey Bell Telephone Co., as president, but did not indicate any details as to the specific location, cost, or time of completion of the new center.

Present quarters at 29 West 39th St., New York City, house the four "Founder Societies:" American Society of Civil Engineers; American Institute of Mining, Metallurgical, and Petroleum Engineers; American Society of Mechanical Engineers, and American Institute of Electrical Engineers. A fifth prospective member, American Institute of Chemical Engineers, will be included in the engineering center project.

Reinforced Group, SPE New York

The Reinforced Plastics Group of SPE's New York Section held its November 28 meeting at Tufaro's Restaurant, Corona, L. I., N. Y., with some 45 members and guests in attendance. Principal speaker of the evening was Edwin Leroy Lotz, Hess Goldsmith & Co., who discussed "New Developments in Glass Fabrics and Finishes for Plastic Reinforcement." His talk was followed by a short address by Maurice Lynch, Silicones Division, Union Carbide & Carbon Corp., on "Finishes for Glass Cloth."

Dr. Lotz reviewed the history of the fibrous glass industry from its inception 15 years ago. He felt that the two-minute closed-press time keeps the industry from making greater inroads into the automotive field, and that more attention must be devoted to pre-impregnations, especially with phenolics and epoxies. Problems encountered with glass fabrics include the removal of oil and starch. Here, the batch-oven method is used for a 72-hour period to obtain clean glass, to which finishes are added. Woven rovings do not have to be heat-cleaned before applying finishes, and results are essentially the same for both wet and dry rovings. A number of specific problems were discussed.

Dr. Lynch explained how finishes were applied to glass cloth, covering silicone finishes, vinyls, epoxies, melamines, and phenolics. Finishes can be applied uniformly, and the amount of material used is not critical. A wet lay-up procedure is suggested as being the easiest to obtain uniform finishes.

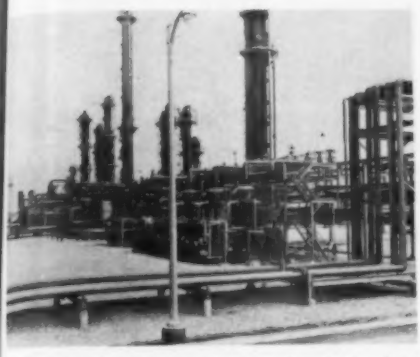
SPE Eastern New England

Approximately 100 members and guests attended a joint meeting of the SPE Eastern New England Section and SPI Boston-Providence Chapter on October 30 at the Hampton Court Hotel, Brookline, Mass. Two talks were featured in the technical session: "Silicones in American Industry," M. E. Nelson, Dow Corning Corp.; and "Epoxy Resins in Non-Surface Coating Applications," H. L. Parry, Shell Chemical Co.

In discussing the uses of silicones, Mr. Nelson noted that a motor wound with silicone resin insulation has withstood a constant temperature of 240° C. for 66,000 hours. Silicone rubbers have withstood temperatures down to –180° F. Silicone foam requires a processing temperature of 350° F. to make foams in the 10-18 pounds per cubic foot density range. A room-temperature foaming material is currently being investigated. Glass fiber-reinforced silicone compound 301 is similar to glass-filled alkyds, but has a temperature resistance of up to 800° F.; a bulk factor of 7:1; molding temperature of 350° F.; and molding cycle of 5-10 minutes, with an after-bake at 250° C. In conclusion, the speaker briefly reviewed silicone laminating resins and the development of a castable that is catalyzed by peroxide and cured at 125-150° C.

Mr. Parry described the chemical aspects of epoxy resin manufacture, and listed the various types of curing agents with their operating temperatures. Operating temperatures as high as 200° C. are a reality, and the 250° C. range is a realistic possibility for the very near future. In discussing formulation variables, the speaker pointed out the desirability of utilizing reactive diluents, instead of solvents, as viscosity modifiers when mechanical properties are to be maintained. Plasticizers and fillers increase toughness, but lower ultimate tensile strength. Fillers decrease the coefficient of thermal expansion, reduce the exothermic temperature, lower the shrinkage, improve the thermal conductivity, and lower the cost. Asbestos acts as an inhibitor with boron trifluoride epoxy catalyst, while copper powder is an accelerator with aromatic amine epoxy hardeners.

NEWS of the INDUSTRY



Carbide & Carbon's new petrochemicals plant in Torrance, Calif.

Carbide Opens Torrance Plant

The first petrochemicals plant on the West Coast was officially opened by Carbide & Carbon Chemicals Co. in Torrance, Calif., on November 2. Located on a 140-acre site, the new unit will employ 350 workers on a 24-hour basis.

Conversion of petroleum gas into ethylene oxide, ethylene glycol, and polyethylene will be carried on in tanks, towers, and miles of pipe. Much of the gas is brought in from the neighboring General Petroleum Co. Production processes will be controlled mainly by automation, and one man can conduct the entire polyethylene-making process from a console-like panel.

Over $2-million has been invested in air-pollution control, and the latest devices have been installed to dispose of unused gases. Employee safety is reportedly assured.

Construction at Torrance began in June, 1953, as part of a major expansion program which has included the building of similar facilities at Seadrift and Texas City, Tex. Carbide's other plants are located at Whiting, Ind.; Institute and South Charleston, W. Va.; and Niagara Falls, N. Y.

New Falls Engineering Lab

A laboratory and research center for experimental die-cutting and splitting of rubber and plastic foams is being opened by Falls Engineering & Machine Co., Cuyahoga Falls, O. Firms having production cutting problems will be invited to send samples of their materials for test shaping, trimming, splitting, and die cutting on FEMCO's special machinery.

Among the machines permanently installed are a heavy-duty roller die-cutter with an automatic loading and unloading mechanism, and an automatic leveling and splitting machine. Additional machinery will be added at a later date.

Dewey & Almy Pilot Laboratory

Pilot plant operations of W. R. Grace & Co.'s Dewey & Almy division will be quadrupled through the construction of a $500,000 laboratory in Cambridge, Mass. Scheduled for completion by February, the unit will house equipment and facilities for the distillation, purification, and storage of monomers.

Reactor equipment sizes will range from one-quart to 300-gallon capacity, in both glass-lined and stainless steel equipment. Designed for operation on a 24-hour basis, the laboratory will be equipped for both emulsion and solvent polymerization. A special high-temperature section will be devoted to polyester, polyamide, and plasticizer research.

Offers Foreign Technical Aid

Dow Chemical Co.'s two export subsidiaries, Dow Chemical International, Ltd., and Dow Chemical Inter-American, Ltd., have contracted for the parent company to supply technical assistance abroad. To this end, a new international section has been formed within the plastics technical service group.

The new section will be headed by Joseph Eveland, former custom service engineer, who will direct its operations with Dow's associated companies in India, Japan, and Wales. The section will also furnish technical service on plastic materials produced by Dow Chemical of Canada, Ltd., in conjunction with that firm's service and development group.

Improves PVA Formulations

Improved formulations of PVA paint during the past year have led to greatly increased consumption, according to officials of Celanese Corp. of America, New York, N. Y., a leading supplier of chemicals and emulsions to the paint industry. The firm estimates that half of the latex paints sold during 1960 will be of the PVA type, as compared to 20% during 1956.

Celanese PVA emulsions have been on the market for only two years, yet make up about two-thirds the volume of the Metropolitan New York market. This fact is reportedly attributable to the improvements in formulation developed at the Summit, N. J., laboratories which overcame most of the original shortcomings. PVA paints are said to afford greated uniformity and appearance due to their minute particle size. Continuous films give greater strength, toughness, and durability to exterior applications.

Cast-concrete pool for housing Battelle's nuclear reactor is three stories high.

Installs Nuclear Reactor

A $750,000 nuclear reactor, the first privately-owned one of its kind, is now being actively used at Battelle Memorial Institute's recently completed nuclear center in Columbus, O. Designed by Battelle physicists and engineered by American Machine & Foundry Co., the reactor uses solid uranium-235 fuel.

The core, composed of fuel elements and boron control rods, is suspended 22 feet below the surface of a large pool of highly purified water. The latter serves as a coolant, and as a protective shield against the radiation. The reactor will be operated 24 hours per day, six days a week.

The research center was built in anticipation of the large expansion of nuclear research made possible by the Atomic Energy Act of 1954 which permits private industry to enter into commercial development of the atom. The center is available to all commercial concerns interested in peacetime nuclear studies.

The million-watt reactor will be used to investigate the chemistry of petroleum; sterilization of pharmaceuticals; preservation of foods; and the improvement of numerous chemicals, glasses, plastics, ceramics, and metallic products.

Glass-Fabric Plant Burns

Over 50% of the fiber glass and plastic honeycomb facilities at Hexcel Products' glass-fabric plant in Oakland, Calif., were destroyed in a five-alarm fire on November 12. The blaze destroyed approximately 6% of the company's total manufacturing area. Fiber glass-fabric production will be resumed within 30 days, and no delays are anticipated in shipments of aluminum honeycomb, stainless steel, and Honeylite lighting material.

Radiation Research Laboratory

Plans for the construction of a million-dollar laboratory to house its recently-established department of radiation research have been revealed by Mellon Institute, Pittsburgh, Pa. The two-story, double-basement structure will be erected on a 125-acre plot located about 20 miles east of Pittsburgh.

This suburban facility represents the first major expansion by the Institute since 1937. Scheduled for completion by summer of 1957, the unit will house a 3,000,000-volt Van de Graaff accelerator, radiochemical labs, offices, library, and equipment for the handling of radio-active chemicals.

Western Plastics Exposition

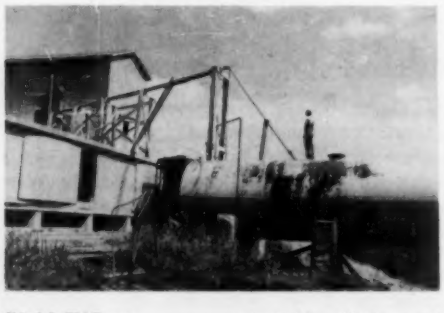
Over 100 national firms have reserved space at the West Coast's first plastics exposition, to be held on March 18-21, 1957, in Shrine Exposition Hall, Los Angeles, Calif. Sponsored by the Society of the Plastics Industry, Inc., the Pacific Coast Plastics Exposition has as its theme "The Dynamic World of Plastics."

The Exposition will be held jointly with the SPI Annual National Conference, and J. Allen Carmien, Nupla Mfg. Co., will serve as general chairman of both affairs. The use of plastics in the aircraft, electronics, packaging, building, and petroleum industries will be highlighted.

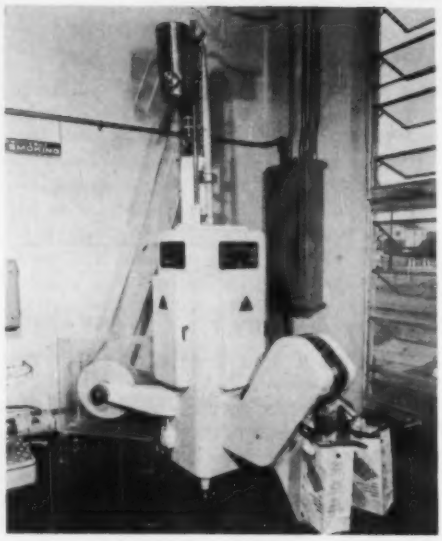
New Use for Rigid PVC Pipe

Rigid Koroseal PVC pipe, produced by B. F. Goodrich Industrial Products Co., is currently being used by the Cotton Producers Association at its plant food division, Carrollton, Ga. The latter firm uses sulfuric acid, water, and concentrated rock dust to produce super-phosphate fertilizers, and found previous pipings required constant maintenance and bi-annual replacement.

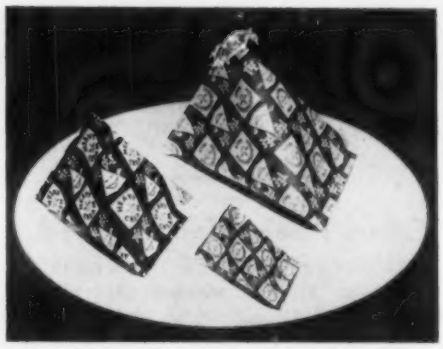
Since the PVC piping was installed last July, no maintenance has been necessary. The Association feels the 75-foot, two-inch diameter pipe to be a permanent installation. Acid concentrations of up to 79% are carried by the pipe from a large outside storage tank to a small tank inside the building.



Rigid PVC pipe conveys 77-79% sulfuric acid without corrosion.



(1) Tetra Pak machine in actual operation.



(2) Sunrise's three sizes of Tee-Pee tetra paks.

Unique Packaging for Liquids

A new method of packaging liquids and semi-liquid food products has been introduced in the United States by Crown Zellerbach Corp., San Francisco, Calif. The method involves the use of a special paper and machine developed by A. B. Tetra Pak, Lund, Sweden. Crown recently signed a contract for manufacturing the paper and promoting the machine in this country.

A roll of printed, heavy white paper is waxed and lined with polyethylene. As it is unwound from its reel, it is formed into a vertical tube and heat-sealed along the side. Another heat-sealing mechanism pinches the base. After filling, the same mechanism makes right-angle seals at intervals below the level of the liquid. Cutters then divide a chain of pyramid-like tetra paks into individual tetrahedral units.

Sunrise Diaries, Hillside, N. J., is the first dairy to use the process commercially. This firm has ¾-, four-, and eight-ounce machines for packaging both milk and cream, which they label Tee-Pee. Complete absence of air space in the filled container is said to assure purity and flavor, and the distinctive shape affords convenient storage and easy handling. Other logical applications for the packaging include fruit juices, soft drinks, ice cream, and individual portions of honey, jelly, and salad dressings.

Koppers To Erect New Plant

A full-scale commercial plant for the production of expandable polystyrene beads will be built by Koppers Co., Inc., at Kobuta, Pa. Presently available in semi-commercial quantities under the trade name Dylite, the material expands in heated molds to take the shape of the enclosure.

Plans call for full-scale operation in 1958. Koppers' engineering and construction division will build the new facilities and some of the existing Kobuta units will be utilized in Dylite production.

Increased Methanol Production

The polychemicals department of E. I. du Pont de Nemours & Co., Inc., Wilmington, Del., is considering an increase in methanol production of some 30-million gallons per year at its Sabine River Works, Orange, Tex. A synthetic alcohol used in the manufacture of automotive anti-freeze and formaldehyde, the material also has application as an industrial solvent.

The bulk of the methanol produced by Du Pont comes from the Texas plant. In an effort to satisfy growing demands for this versatile chemical, the company recently resumed making methanol at its plant in Belle, W. Va., but new facilities are needed.

New Atomic Research Company

Ten American firms have joined forces in a new company, Industrial Reactor Laboratories, Inc., to build and operate a nuclear reactor at Plainsboro, N. J., for industrial research in atomic energy. Participating companies are Atlas Powder Co., AMF Atomics, Inc., American Tobacco Co., Continental Can Co., Corning Glass Works, National Distillers Products Corp., National Lead Co., Radio Corp. of America, Socony Mobil Oil Co., and United States Rubber Co.

Each participant will be represented on the new company's board of directors, which will be headed by Walter Bedell Smith, president, and H. L. Hilyard, vice president. Mr. Smith is chairman and president of AMF Atomics, and Mr. Hilyard is treasurer of American Tobacco Co.

Artist's concept of Industrial Reactor Laboratories in Plainsboro, N. J.

Budd's radioisotope handling facility.

To Fabricate Radioisotopes

A facility for the fabrication of radioisotopes in strengths up to 10,000 curies has been established by the Budd Co., Philadelphia, Pa. Set up under license by the Atomic Energy Commission, the facility is part of the firm's new nuclear systems division which also produces radiography equipment for the non-destructive testing of metals.

The facility consists essentially of a heavily shielded "hot" cell; a master-slave manipulator; a shielding window of 36-inch high density glass; a closed-circuit television; and miscellaneous equipment. Fabrication involves the building up in wafer, rod, and other forms of strengths up to 10,000 curies of Cobalt 60, Cesium, Thulium, Iridium, and other isotope materials. These are encapsulated in specially designed containers for shipment and storage.

Budd plans to maintain an inventory of the more common, long-life isotopes in bulk form to expedite their fabrication, and will design and build equipment for the controlled exposure of such sources. This will include associated instrumentation and control apparatus.

Expands Petrochemicals Plant

A major expansion of its petrochemicals plant at Port Neches, Tex., has been started by Jefferson Chemical Co., Houston, Tex. The move is expected to triple ethylene production, double the unit's ethylene glycol capacity, and increase ethylene oxide production by about 50%.

The program will include the installation of a direct oxidation unit to produce ethylene oxide, which will supplement the plant's chlorohydrination equipment. A separate plant will be erected for producing chlorine, and dock and storage facilities will be installed. The new facilities will mark Jefferson's entry into the propylene derivative field.

Further Reichhold Expansion

Two formaldehyde plants have been added to existing facilities at Detroit, Mich., and Tuscaloosa, Ala., by Reichhold Chemicals, Inc. It is estimated that each will produce 35 million pounds per year. At Tuscaloosa, pentaerythritol production will be stepped up from four to ten million pounds annually, and phenol production from 50 to 75 million pounds.

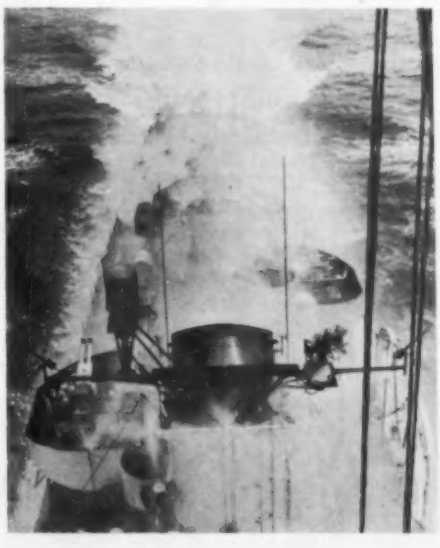
A bigger move involved the licensing of Reichhold to produce epoxy resins under the Devoe & Reynolds patent. Non-exclusive in scope, this license marks Reichhold's entry into this expanding field. Devoe, a division of Merritt-Chapman & Scott Corp.'s chemical, paint, and metallurgical department, is a pioneer in epoxy development.

Vinyl Washdown System Guards Against Atomic Fall-Outs

Washdown systems are required to protect Navy ships from contamination by radioactive fall-out during atomic blasts. Metal pipe and fittings added so much weight to the ships that their combat effectiveness might have been seriously impaired. A new system was developed by Grinnell Co., Providence, R. I., and the Navy's Bureau of Ships, which employed B. F. Goodrich's Geon vinyl resin exclusively.

The Grinnell system employs over 120 different designs of rigid vinyl pipe, fittings, bushings, adaptors, hose connections, hose racks, hangers, and spray nozzles. Adhesives are furnished for fast and efficient assembly, and adaptors permit the system to be tied into the ship's fire protection mains.

In addition to light weight and the elimination of threaded joints, the system is flexible and non-corrosive. Sea water has no effect on the material, and it will not support marine growth.



Vinyl washdown system on the USS Purdy.

How to Solve Problems with Wood Flour

Research and Technical Assistance

In a field that is expanding as rapidly as the wood flour industry, research and development effort are vital in enabling the user to adapt wood flour efficiently to new and improved uses.

The Wilner Company maintains a continuing research program in wood flour utilization, supplemented by the services of a leading firm of industrial research consultants.

These services are available at no cost, to help any interested concern in solving development and/or processing problems involving use of wood flour.

Typical Analysis
100 Mesh Wood Flour

Thru	On	
	80	Trace
100		96.0
120		65.2
140		48
170		36.4
200		22

Among the users of Wilner Wood Flour

ARMSTRONG CORK CO.
BIRD & SON
BONAFIDE MILLS, INC.
GENERAL ELECTRIC CO.
ROHM & HAAS CO.
STANDARD TANK & SEAT CO.

For samples, further information and specifications, please write. I-1D

Wilner Wood Products Co., Norway, Me.

Acquires Lansco Die Casting

Lansco Die Casting Co., El Monte, Calif., has been purchased by New Plastic Corp., Los Angeles, Calif., manufacturer of surface-protective hammers and plastic wall tile. The new subsidiary will continue to offer engineering, design, tooling, and parts service to the automotive, hardware, plastic, and associated industries.

Acquisition gives the parent company control of costs and quality for many of its existing products, and opens new avenues for product design through the combination of plastic and metal. Key personnel will be retained, including William B. Lane as president and general manager. Immediate plans call for expanding sales operations, using New Plastic's nationwide sales organization.

Koroseal Vinyl Vapor Barrier

Koroseal vinyl film is gaining acceptance as a protection against fire and water hazards, according to spokesmen at B. F. Goodrich Industrial Products Co., Akron, O. The material, used as a vapor barrier between roof deck and insulation, prevents the dripping of inflammable asphalt or tar which can add to the seriouness of industrial fires. Modified versions of industrial roofs are also applicable to flat-top buildings, non-combustible decks, and wood roof decks.

Among the leading industrial firms which have already installed the Koroseal vapor barrier are Aluminum Co. of America, Bethlehem Steel Corp., Ford Motor Co., General Electric Co., International Nickel Co., Koppers Co., and Republic Steel Corp. Developed by Lexsuco, Inc., Cleveland, O., the vapor barrier has been proved by Factory Mutual tests as fire retardant with a Class 1 rating.

Use of the film for portable dams in irrigation ditches and as silage covers is gaining acclaim, and the material also has been employed to protect machinery against the elements. Goodrich feels that the vinyl film industry will match last year's consumption of resin.

Ekco Purchases Plasteel

The Plasteel division of P. R. Mallory Plastics, Inc., has been purchased by Ekco Products Co., according to a joint announcement by the two Chicago firms. The Plasteel line of plastic bathroom accessories will be manufactured and distributed by Autoyre Co., Ekco's wholly-owned subsidiary. The latter firm has been a leading manufacturer of metal bathroom and closet accessories for many years.

Mallory reportedly decided to abandon the Plasteel line in order to secure additional manufacturing space for its expanding line of plastic dinner and picnic ware.

. . . it takes time

Great oaks take time. Great plastics, too! America's next great plastic—GREX—is being readied for market at a steady, measured pace. We are taking time to prepare with utmost care the applications and marketing data that will enable each customer to use this new resin with maximum ease, efficiency and profit. It takes time.

GREX*

Clifton, N. J. Baton Rouge, La.

*Trademark for W. R. Grace & Co.'s polyolefins

POLYMER CHEMICALS DIVISION
W. R. GRACE & CO.

In Brief . . .

B. F. Goodrich Industrial Products Co., Plastics Products, Marietta, O., has introduced a new, air-porous Koroseal upholstery pattern called Larchmont, and two wall and upholstery patterns labeled Mequis and Bali. Larchmont is available in 13 colors; the latter patterns in 14 different hues.

General Tire & Rubber Co.'s Bolta Products division, Lawrence, Mass., has introduced seven new designs in its Boltaflex Decor-Eze, a self-adhesive vinyl covering material for the do-it-yourself market.

Pantasote Co., Passaic, N. J., has moved its New York offices from 444 Madison Ave. to 415 Madison Ave., New York City.

Monsanto Chemical Co.'s plastics division, Springfield, Mass., has announced a one-cent per pound increase in the price of acrylonitrile as of October 1.

Owens-Illinois Glass Co., Toledo, O., has announced an increase across-the-board for nearly all of its products. This includes glass containers, molded plastic closures, Libbey glassware, Kaylo insulation and the products of its subsidiary, Kimble Glass Co.

Mayhew Products Co., Los Angeles, Calif., has appointed Rainville Co., Garden City, N. Y., as national distributor of its oil-reconditioning units for the plastics industry.

Lowell Technological Institute, Lowell, Mass., has authorized the awarding of associate degrees in engineering for completion of a program in plastics engineering. The program will require four years to complete, and will require attendance at three evening sessions per week throughout two 15-week terms per year.

Mobay Chemical Co., St. Louis, Mo., has announced price reductions up to 36% on basic chemicals used in the manufacture of urethane surface coatings and related products. These include both isocyanates and polyesters.

Schwartz Chemical Co., Inc., New York, N. Y., has effected a major expansion of its sales organization through the appointment of 20 representatives throughout the United States and abroad. The firm manufactures dyes, lacquers, and adhesives for the plastics industry.

News from Abroad

Plastics in Italy, 1955

Italy's plastics industry is advancing steadily, recent data reveal. In 1955, production of all types of plastics came to 87,000 metric tons and consumption to 76,000 tons, as compared with 80,000 and 61,000 tons, respectively, in 1954. Both imports and exports also rose, the former from 7,614, to 12,188 tons, and the latter from 18,364 to 28,496 tons. Incidentally, exports exceeded imports for the first time in 1954. Foreign trade in the chief plastics during 1955, in metric tons, was as follows:

	Imports	Exports
Cellulose acetate	2,931	426
Phenolics	437	252
Aminoplastics	3,417	428
Polyesters	456	57
Linear condensation products	257	19
Polymerization products	3,537	26,984

Italy produced 8,870 tons of phenolic molding powders in 1955, an increase of almost 27% from the 7,000 tons of 1954. It is expected that local consumption of these powders will continue to expand because prices in Italy are lower than in other countries, while a complete assortment of types is available, technology is advanced, and equipment is up-to-date. On the other hand, phenolic laminates for industrial purposes must be imported to some extent, chiefly from England and Germany. The situation in decorative laminates is better, and consumption is growing. Phenolics also are being introduced for foundry work in Italy.

As for urea and melamine resins, most progress in Italy seems to have been made in adhesives for wood, in varnishes, and in preparing paper for laminations. Molding powders of these resins are hampered by competition from various countries for certain uses; Japan, in particular, offers keen competition in materials for button manufacture.

The vinyl resin industry is making much headway in Italy, and consumption increased from 9,000 tons in 1954 to 14,000 tons in 1955, a rise of 55%. This brings per capita consumption in 1955 to 300 grams, as compared with about 1½ kilograms in the United States. Demand is expected to continue growing at a rapid rate, and an annual consumption of 30,000-40,000 tons is looked for by 1960. New vinyl copolymers have begun to be produced in Italy, but their use is still limited by lack of experience on the part of local manufacturers. Before they were made in Italy, the high prices of the imported copolymer materials precluded experimentation on any considerable scale.

The use of polyethylene is increasing rapidly, chiefly for injection molding and the production of film. Acrylics for molding must be imported from Germany and the United States, but the consumption requirements for acrylic latices are covered by local output. Workshops, rather than the larger manufacturers, are doing most of the work with polyesters at present, so that only 500 tons of reinforced polyester resin were actually used in Italy in 1955.

Societa Crespi, of Legnano, and Pirelli produce polyurethane type materials under license from Bayer, in Germany. The basic materials for foamed polyurethane, Moltoprene, must still be imported. Montecatini has begun to manufacture polyethylene terephthalate at Ferrara, and markets the product under the name, Terital.

British Expansion Plans

A new styrene plant to cost £1,750,000 (about $4,900,000), will be erected at Partington, on the Manchester Ship Canal, by Petrochemicals, Ltd., an associate of the Shell group. The plant is expected to be in operation in 1958, and will provide Styrene Products, Ltd., a wholly-owned subsidiary of Petrochemicals, with monomer for making polystyrene molding powders.

Monsanto Chemicals, Ltd., is starting on a long-term expansion program for the manufacture of industrial chemicals from petroleum. It will spend £8,500,000 on the first stage of this undertaking, which includes a new factory to be built on a 100-acre site at Fawley where materials will be produced for the plastics, rubber, textile, paint, and other manufacturing industries. This plant will be adjacent to the refinery of Esso Petroleum Co., Ltd., which will supply feed stock. First, Monsanto will start producing polyethylene at the annual rate of 10,000 tons, probably by 1958. Next, copolymers of acrylonitrile, butadiene, and other monomers will be made. Finally, a large plant will be erected to manufacture acrylonitrile, which is not yet made in Britain.

British Hydrocarbon Chemicals, Ltd., jointly owned by The Distillers Co., Ltd., and British Petroleum Co., Ltd., is to build a £25,000,000 polyethylene plant at Grangemouth, Scotland. The Phillips catalytic process for polyethylene and other polyolefin plastics is to be used.

Plastics in The Netherlands

Lack of raw material sources has necessitated Netherlands' importing of relatively large amounts of plastic sheet, rods, tubes, and powders; however, 35 firms are engaged in the manufacture of plastic materials. Over 100 other companies are engaged in compression and injection molding, extrusion, and laminating.

In 1955, total material imports amounted to nearly 26,000 tons; a four-fold increase since 1948. Value was estimated at $16-million. Principal suppliers were West Germany, 30%; Belgium, 26%; Great Britain, 22%; United States, 9%; and the remaining 13% came from France and the Scandinavian countries.

The estimated 26,000-ton production in 1955 was about 18% greater than the 1954 tonnage. Domestic production is concentrated in the field of thermosets, which account for 77% of the total output. Netherlands State Mines, one of the largest chemical producers, will commence polyethylene production in 1957. An American subsidiary will manufacture styrene, and plans are under way for increasing PVC productive capacity.

Futures are reportedly bright, and considerable expansions of both materials and product manufacture are expected. Considerable competition among manufacturers has sprung up, particularly with respect to finished items.

Reinforced Alkyd Compounds

A French company has begun the manufacture of an alkyd compound for compression molding which is claimed to possess in heightened degree the outstanding properties of polyesters. Designated Terolith MIX, the compound incorporates a high proportion of glass fibers of varying lengths, giving the material the consistency and appearance of dry, fibrous flakes. It can be molded directly without pre-heating, and does not require the addition of catalysts. The compound contains a dormant catalyst which is inactive at normal temperatures, but takes effect at 110-140° C., so the compound can be stored for several months.

During the molding process, the compression chamber is filled, the mold closed, and a pressure of 700-2,800 psi. applied. The resin becomes liquid and, together with its glass fiber filling, penetrates all parts of the mold. Polymerization is initiated and proceeds unaided without releasing volatile substances. The molding process takes 39-120 seconds. The finished piece is easily removable without the aid of a mold-release agent, and has a smooth, glossy surface. There is no deformation due to shrinkage. The Charpy test reveals an impact strength of 100-110 times that of phenoplasts or aminoplasts. Electrical insulation properties and arc resistance are said to approximate that of porcelain, while chemical resistance is the same as for polyesters.

NAMES in the NEWS

Carbide and Carbon Chemicals Co., New York, N. Y., has added the following 14 men to its sales force: **L. R. Graham, G. O. Fishburn, R. C. Muller, H. M. Jones, Jr., J. W. Demaree, E. P. Cass, H. R. Hubbs, T. J. Kuzara, N. J. Hill, A. M. Chagares, A. V. D'Amelia, G. W. Shoemaker, W. C. Friedemann,** and **A. G. Breckling.**

Donn Snyder has joined Columbian Carbon Co.'s Carbon Black & Pigment division, and will make his headquarters in the company's Boston sales office. He previously served with Goodyear Tire & Rubber Co.

Harry A. Russell

Harry A. Russell has been appointed vice president of the H. O. Canfield Co., Bridgeport, Conn., manufacturer of mechanical-rubber and extruded-vinyl products. He will direct technical operations of the firm's three plants in Bridgeport, Clifton Forge, Va., and Seymour, Ind.

Frank A. Mather has been assigned to Goodyear Tire & Rubber Co.'s chemical division sales office in Philadelphia, where he will work primarily with Chemigum, Pliolite, and Pliovic latices.

Leonard I. Meisel, former supervisor of the plastics branch, Naval Air Material Center, has transferred to the Philadelphia Quartermaster Depot to become civilian chief of the testing laboratories. He had been serving the Naval Air Experiment Station for the past 15 years.

Alan W. Bryant has been appointed eastern district sales manager for Columbian Carbon Co.'s Carbon Black & Pigment division, with offices in New York City. He served with Binney & Smith until the 1955 merger with Columbian, most recently heading-up the Boston sales office.

Lawrence Charnas has been appointed research associate in Ferro Chemical Corp.'s photosensitive vinyl department, Bedford, O., where he will continue research on Calimar flexible vinyl film.

Leonard J. Gosselin has joined the Hetron technical service group at Hooker Electrochemical Co.'s Niagara Falls, N. Y., plant. He previously served as plastics engineer for United Shoe Machinery Corp.

Elmer E. Mills has opened a consulting office at the Field Building, 135 S. LaSalle St., Chicago, Ill. He has over 20 years experience in the plastics industry, having opened his own custom molding plant in 1937. Mr. Mills developed a method of producing polyethylene containers, which was purchased by Continental Can Co.

Fred R. Wilson has been appointed director of sales for Du Pont's explosives department succeeding **George H. Loving,** new assistant general manager of the photo products department. **William D. Garwood** replaces Mr. Wilson as director of manufacturing. **Richard D. Hedreen,** manager of the technical service section, succeeds Mr. Garwood as assistant director of sales.

Robert B. Wilbur has been appointed sales manager, polyurethane products, for The General Tire & Rubber Co. Former manufacturers sales representative for General's eastern division, he will report to **John O'Grady,** manager of the Marion, Ind., plant operation.

Robert Derenski has been appointed manager of custom sales for the plastic and metal divisions of Santay Corp., Chicago, Ill. He previously served as chief process engineer, and had his own tool manufacturing business.

William C. Wiley has been named to head up a new market development program for Borden Co.'s Polyco-Monomer department, New York, N. Y. He will coordinate all resin marketing activities, including thermoplastics and emulsions.

Patrick J. Tuohy Charles E. Doughty, J.

Charles E. Doughty, Jr., and **Patrick J. Tuohy** have been appointed vice president of Flightex Fabrics, Inc., New York, N. Y. Both men have been serving in the firm's sales department for the past ten years.

James D. Wilson has been named to head-up the sales service staff of Baker Castor Oil Co.'s plastic & rubber laboratories. He was formerly associated with Onyx Oil & Chemical Co. **Louis E. Machado** has joined the commercial development staff as assisting chemist of the quality control department.

Milton A. Sanders has joined the field sales staff of F. J. Stokes Corp.'s plastics molding equipment division, and will work out of the New York district office. Since 1936, he has served as mold designer for Claremould Plastic Co.; as general manager of Bloomfield Molding Co.; and as chief research engineer for Sun Tube Corp.

H. Joseph Sharkey has joined the organic research staff of Emery Industries, Inc., Cincinnati, O. Dr. Sharkey is a recent graduate of Oregon State College.

J. D. Fitzpatrick

J. D. Fitzpatrick has been appointed manager of the newly-created basic research section of Emery Industries, Inc., Cincinnati, O. He previously served as manager of the new chemicals department. Assisting Dr. Fitzpatrick will be **Kenneth N. Warner,** former member of Emery's organic research section.

George Karian has been appointed manager of F. J. Stokes Corp.'s tabletting division, Philadelphia, Pa., having previously served as sales specialist for industrial compacting presses. Among his other duties, Mr. Karian will direct design and sales of Stokes hydraulic and mechanical compacting presses for plastics preforming.

Names in the News (Cont'd)

John J. Healy, Jr., has been named director of general development for Monsanto Chemical Co.'s research and engineering division, St. Louis, Mo. He succeeds **Hal G. Johnson,** who has taken a six-month leave of absence to undertake a government assignment in Washington. Mr. Healy had been assistant to the vice president in charge of research, development, and engineering.

Harold J. Dawe has been appointed technical staff consultant of Acheson Industries, Inc. with offices in Port Huron, Mich. Former director of research for Acheson Colloids Co., Dr. Dawe will supervise the technical activities of all seven Acheson plants.

Paul J. Flory, professor of chemistry and acting chairman of the department of chemistry at Cornell University, has been named to head Mellon Institute's investigational activities as executive director of research. The post has been established since the recent retirement of **Edward R. Weidlein** as president.

E. J. Mills, Jr., has been assigned to a newly-created staff position at the South Charleston, West Va., plant of Carbide & Carbon Chemicals Co. He will be concerned with special technical assignments and the recruitment of technical personnel. **L. F. Theiling** and **V. T. Stack** have been appointed group leaders within the plant's development department.

Frederic S. Dawn has joined the technical staff of Decar Plastic Corp., Middleton, Wisc., as laboratory director. The firm is engaged in the manufacture of plastic laminates, primarily for the furniture industry.

Giffin D. Jones has been appointed director of Dow Chemical Co.'s physical research laboratory at Midland, Mich. He succeeds **W. C. Bauman,** who was recently named director of research for the company's chemicals department. Dr. Jones had been assistant to Dr. Bauman.

G. J. Crowdes has been appointed district manager of Dennis Chemical Co.'s Ohio office. He will direct operations in that State, Pennsylvania, New York, and Michigan. Dennis manufactures plastisols, specialty coatings, and adhesives in St. Louis, Mo.

Walter S. Beanblossom has been named administrative assistant to management at Hooker Electrochemical Co., Niagara Falls, N. Y. He previously served as supervisor in the research and development department.

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reduce over-all cost while formulating quality with . . .

The complete line of THERMOLITE organotin Stabilizers for polyvinyl chloride resins and other chlorinated resins offer outstanding advantages to compounders of rigids or flexibles. Thermolite Stabilizers assure consistently clear, brilliant, transparent stocks. Formulating problems are simplified, production is stepped up. Overall compound costs are lowered because Thermolite Stabilizers provide more *working* material per dollar invested in stabilizer. There is no more economical nor better method for producing and safeguarding quality vinyl products.

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For rigid vinyls, flexible stocks, extruded vinyls, blown film or plastisols there is a specific Thermolite or combination of Thermolite compounds that can achieve the results you seek. If your need is high clarity or high thermal stability—weatherability, water resistance, less pinholing, easier curing or any one of dozens of requirements, investigate the advantages of Thermolite Stabilizers. Write for more complete information.

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TIN & TIN CHEMICALS • CERAMIC MATERIALS • ORGANIC COATINGS • WELDING SUPPLIES
RADIOGRAPHIC EQUIPMENT • PLATING MATERIALS • METALS & ALLOYS • HEAVY MELTING SCRAP

New Materials

Write item numbers on Readers' Service Card to obtain more information.

Non-Reactive Thickening Agent

A multi-purpose thixotropic agent for paints, adhesives, polyesters, epoxy resins, lubricants, and plastisols has been placed on the market by Ferro Chemical Corp. Called Viscotrol-A, the material is a finely-divided, white powder which is practically odorless and tasteless.

Viscotrol-A reportedly maintains uniform viscosity over long periods of aging, an improvement over many of the existing thickeners. Non-yellowing, the material is impervious to water, phenol, polar solvents, basic, and acidic components. It has a specific gravity of 0.98, and a bulking value of 0.33-gallon per pound. Melting point is 86° C.

Viscotrol-A is non-reactive chemically, and is insoluble in most organic liquids. Amounts added will vary according to the system involved; however, a concentration of 2-3 pounds per gallon makes a good starting point for determining the optimum quantity to be added. Maximum beneficial effects are achieved by adding it as part of the pigment grind.

Readers' Service Item M-1

Low-Viscosity Epoxy Hardener

A hardener, specifically designed for use with Sonite X1 epoxy resin casting compound, has been placed on the market by Smooth-On Mfg. Co. Designated Sonite No. 23, the material is said to impart flame resistance, long pot life, low viscosity, resistance to mechanical and thermal shock, and good electrical properties.

Mixing is done at room temperature, using 140 parts of hardener to 150 parts of resin by weight. Cure is accomplished in two hours at 250° F., though parts may be removed from the mold in one hour. Other properties are reported as follows:

Color	Amber
Heat distortion point at 264 psi., ° C.	72
Flammability	Self-extinguishing
Thermal shock, type B.	Passes

Readers' Service Item M-2

Stabilizing Thixotropic Agent

A combination stabilizer, thickener, and leveling agent for latex and emulsion paints has been developed by Borden Co.'s chemical division. Known as Cascoloid ST-50, the dispersion contains 25% biologically-stable casein solids in water. Total solids content is 47-49%, the 22-24% difference consisting primarily of alkali solubilizers.

Borden recommends halving the preservative content of formulas employing ST-50 instead of other casein forms. Although no biological decomposition was reported when all preservatives were eliminated, viscosity was found to be lowered. ST-50 has a viscosity of 30-40,000 cps., at 70° F., and a pH of 7.2-7.4. Weight per gallon is 9.6 pounds. The white dispersion is dilutable with water and water-soluble plasticizers.

Storage life of this prepared stabilizer is unlimited under normal conditions, and it is unharmed by freezing. ST-50 can be added to pigment grind, pigment slip, or divided between the two. It is packed in internally-coated five-, 30-, and 55-gallon drums.

Readers' Service Item M-3

Polymeric Primary Plasticizer

A polymeric plasticizer based on neopentyl glycol has been introduced by Eastman Chemical Products, Inc. Intended as a primary plasticizer for vinyl resins, the material is said to feature outstanding permanence properties, resistance to hydrolysis, low-temperature flexibility, ease of handling, and low color rating.

Following are specifications reported for the material:

Color, APHA max.	100
Acid number, max.	2
Hydroxyl content, %	0.2
Molecular weight	1,200-1,300
Refractive index	1.4656
Specific gravity	1.06
Water solubility, gms./liter	0.1
Boiling water stability, % hydrolysis @ 96 hrs.	8.9
Flash point, ° F.	535
Fire point, ° F.	630
Viscosity @ 32° F., cps.	37,000
At 50° F., cps.	14,000
At 70° F., cps.	5,000
At 90° F., cps.	2,100
Volume resistivity, ohm-cm.	9.2×10^{12}
Dissipation factor @ 1 mc., %	1.14
Dielectric constant @ 1 mc.	4.55

Readers' Service Item M-4

Cleaner and Destaticizer

Two new compounds for the surface treatment of plastics are available from the Louis P. Hershey Co. The first, called Lustrar Compound, is intended for restoring finish, cleaning, and polishing acrylics. The second, Lustrar Tri-Glo Anti-Static is reported to act as a permanent destaticizer for all plastic surfaces.

Lustrar Compound consists of three essential parts: a polymerized wax compound containing several otherwise-incompatible materials; a polymerized oil compound in which three otherwise-immiscible materials are combined; and an abrasive combination which is incorporated into the other two at a precise temperature and speed.

Non-crazing, non-solvent, non-flammable, and non-toxic, the material will remove solvent and cement damage spots provided they have not penetrated too

deeply below the surface. A small amount is applied with a soft cotton cloth and rubbed briskly until the red color disappears. Excess is removed with a clean cloth, and the surface rubbed to a high gloss. A single operation reportedly obviates the need for wet or dry grinding, sanding, filing, and ashing. Inherently heat-resistant, Lustrar Compound will withstand temperatures of 212° F. Although originally developed for use with acrylics, it also was found to be effective with acetates, vinyls, styrenes, and phenolics.

Lustrar Tri-Glo Anti-Static is a milky-white water dispersion with a terpene-like odor. Applied with outing flannel cloth and allowed to dry, it has withstood more than 5,000 dry rubs and more than 1,200 wet rubs without appreciable development of static charge.

Readers' Service Item M-5

Perforated Polyester Film

A new process has been developed by Kendall Co.'s plastic film department for perforating Du Pont's Mylar polyester film. The resultant material is heat-sealable, and is available plain, colored, or metallized.

The film is expected to find numerous applications in the electrical field as an insulation material, mica bonds, and laminations. Among the numerous consumer and industrial possibilities are filters, screens, packages, silk screens, and breathing membranes.

Perforations can range from 0.02-0.203 inch in size, be in either straight or staggered lines, and can be varied in number from 14-900 per square inch. Open area thus can be varied from 18-48%. All different film widths are available, from 1-36 inches. Physical, chemical, electrical, and thermal properties are identical with those quoted for similar gages of standard Mylar.

Readers' Service Item M-6

Modified Styrene Material

A modified styrene resin in pellet form, known as Plio-Tuf P100, has been developed by Goodyear Tire & Rubber Co.'s chemical division for use in injection molding and extrusion applications. Featuring high impact strength and a high heat-distortion point, the material shows the following physical properties in injection molded specimens:

Specific gravity	1.05
Tensile strength, psi.	4,500
Elongation, %	20
Hardness, Shore D.	74
Rockwell R.	81
Stiffness in flexure, ⅛-in. bar, psi.	261,000
Impact strength, notched Izod, 77° F., ft. lbs./in.	5.3
At —20° F., ft. lbs./in.	1.5
Softening point, °F.	203
Heat distortion point, 66 psi., °F.	211
At 264 psi., °F.	186

P100 has been injection molded on cycles and with temperatures used with conventional materials. External lubricants are generally not needed due to material's excellent flow characteristics. Heated molds up to 195° F., are required for optimum gloss, and cylinder temperatures will range from 350-475° F.

The material reportedly shows good extrusion characteristics on standard equipment. Full-flighted screws are preferred for maximum output, with rate of extrusion being dependent upon the type of machine and gage of the material. Drying of pellets is recommended after storage periods. Extruded sheet is readily adaptable to post forming by any of the conventional methods.

Readers' Service Itm M-7

VANSTAY Z

zinc bearing chelator for PVC resins imparts outstanding clarity, stability and resistance to sulfur staining when used as recommended with other VANSTAYS in many vinyl products.

Plastisols, Organosols, Extruded Goods

Use 1.5 VANSTAY R with .5 VANSTAY Z for maximum resistance to process heat and good service life.

Film, Sheeting, Molded Products

Use 1–1.5 VANSTAY HT with .5–1.5 VANSTAY Z to obtain the required protection.

When Roll plating is a problem:

Use 1.5 VANSTAY N with 1.5 VANSTAY Z as the stabilizing system.

Our Technical Service Representatives will gladly demonstrate the merits of our materials in your plant and assist in solving production problems.

R. T. Vanderbilt Co., INC.
230 PARK AVENUE, NEW YORK 17, N. Y.

Oliver

New Equipment

Write item numbers on Readers' Service card to obtain more information.

Rivet-Type Threaded Inserts

Rivet-type inserts which provide a deep, full thread in plastic and other sheet materials have been developed by Standard Insert Co. They are swaged or silver-soldered in position, and are available in two series; tapped straight through, and blind.

The inserts are marketed in all regular thread sizes from #2-#10. Five shank lengths can be obtained, permitting installation in 1/32-5/32 inch sheets. Class 2 threads are standard, but Class 3 threads can be furnished to order. Stock rivets are brass, but cadmium-plated rivets can be specified.

Standard's rivet-type inserts.

Readers' Service Item E-1

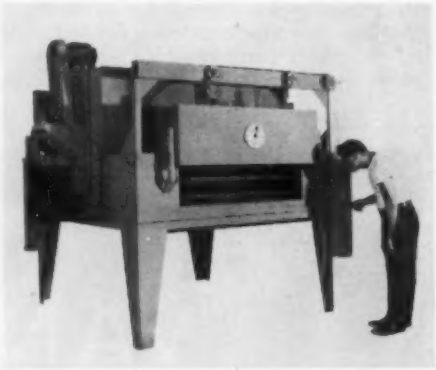
Pre-Heating Oven for Acrylics

An oven for heating acrylic materials prior to forming has been introduced by Despatch Oven Co. Electrically heated by a 35-kw. system, the oven features horizontal air flow and can handle up to 150 pounds of material.

Working height is 42 inches above the floor, and inside dimensions of the oven itself are 48 inches wide by 72 inches deep by 12 inches high. It has double walls separated by four inches of Rockwool insulation; the inner wall consisting of 22-gage oven steel. Counterbalanced, lift-type doors afford easy access from front or rear. Two shelves of #16 gage, ½-inch steel Shelfax are welded to the heavy-duty frame.

Open-coil, low-gradient heating elements mounted in an insulated chamber are located at the top of the oven above the work chamber. They consist of Nichrome wire set in high-temperature porcelain insulators. A balanced-belt fan rated at 1,400 cfm. is built into the heater chamber to provide air flow. Heated air is forced down into the supply duct through louvers, which distribute the air horizontally across the materials. Air leaves the oven chamber through recirculating ducts, and returns to the fan and heater chamber for additional cycles of air circulation.

A Micromatic indicating control with a



Despatch pre-heater oven for acrylic sheet.

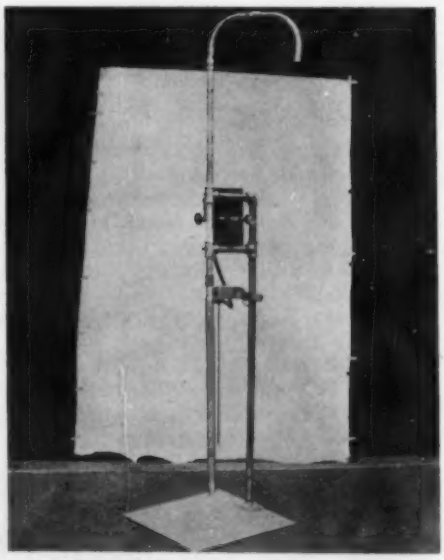
range of 100-600° F. operates the electrical heating equipment within close limits. The sensitive element is mounted in the oven proper, and control equipment is set in a separate box on the outside. An exhaust fan, provided with an adjustable damper, is located on the roof of the oven.

Readers' Service Item E-2

Two Automatic Hopper Loaders

Two new loaders offered by the Rainville Co., Inc., are the Aero-Sonic, a portable unit based on the Venturi aerodynamic principle; and the Rainco Vacuum-Type Loader. Both are fully automatic.

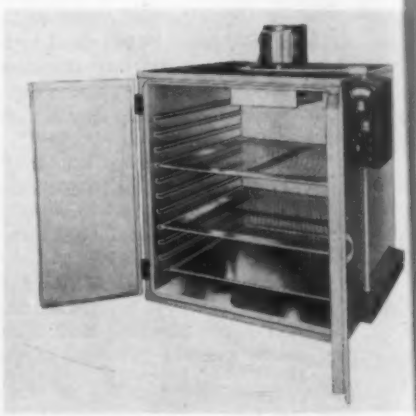
The Aero-Sonic is recommended for use with injection molding machines, and will load approximately 200 pounds of pelletized material per hour. Loads up to 450 pounds can be accommodated; however, the horsepower drain on the air compressor makes the operation economically unsound. The compressed air causes the material to be drawn out of the drums and into the hopper in a continuous, automatic fashion. Optional parts include an agitator for eliminating cavities and clogging of reground material, and a timer and solenoid for automatic control at rates below 200 pounds per hour.



Rainville Aero-Sonic hopper loader.

The vacuum loader is particularly effective in loading dry-colored polyethylene, finely-granulated styrene, phenolics, and finely-blended dry vinyls. Loads up to 1,000 pounds per hour can be accommodated; a feature of special value to extruders. Suitable feed tubes, elbows, and connectors are furnished for mounting the loader as high as 15 feet. A solenoid-operated clapper seals the vacuum chamber while material is being pulled from the drum, and the hopper-level control switch automatically starts the cycling timer when the machine requires material. The control box can be mounted at any convenient location. It operates on 110-volts, and contains an automatic timer for stopping the flow of air.

Readers' Service Item E-3



Model 333 Grieve-Hendry bench oven.

27-Cubic Foot Bench Oven

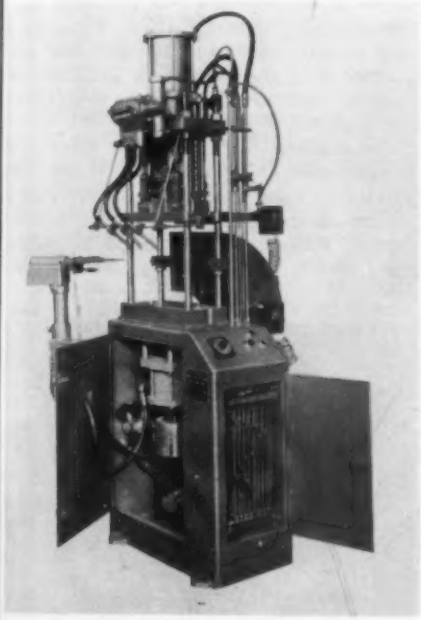
A bench oven with a working space measuring 36 by 36 by 36 inches, has been placed on the market by Grieve-Hendry Co., Inc. Designated Model 333, the oven features a fan-driven, forced-air circulation system which maintains even temperatures over a 100-350° F. temperature range. Damper is readily adjustable.

Construction is of heavy-gage steel, with a minimum of two inches of Fiberglas insulation. Tubular heating elements are Inconel sheathed, and shelf supports rest on three-inch centers. Shelves are removable, and can be inserted to fit each particular job. A Partlow non-indicating temperature controller is available as optional equipment.

Outside cabinet dimensions are 40 by

...l by 43½ inches high. The oven is ...rketed with 220 volts, one phase, 60 ...cles; 220/3/60; or 440/3/60. Timer, ...ilot light, and automatic door switch ...re all optional equipment. Applications ...or the oven include baking of enamel ...nd other finishes, dehydrating, preheating, ...nd other types of processing and labora...ory usages.

Readers' Service Item E-4



Stokes Model 725 automatic press.

Automatic Air-Operated Press

A 25-ton, fully-automatic, air-operated press has been introduced by F. J. Stokes Corp.'s plastics molding equipment division. Known as Model 725, the unit was designed for short production runs where low mold costs and quick mold set-up are desired.

The press can be equipped with a universal chase plate, which permits cavities to be changed quickly without removing the chase plates. Featured are an adjustable, three-station rotary feeder; a separate, cam-actuated, air-ejection system; and an air-operated push-off, which can be "sequenced in" at any point in the press' open cycle. Top ejection, or bottom ejection with top hold-down, is possible with a 2½-inch maximum ejection stroke.

Stokes' bar controller provides for fast change-over in the molding cycle, thus accommodating bumping, breathing, and multiple air-blast. Operator safety is assured through micro switches which prevent the mold's closing unless all moving members are free of the molding area. Pressure is exerted by means of a seven-inch main ram cylinder, the action of which is multiplied through a toggle arrangement. An over-all, dry-cycle time of five seconds includes feeding, closing, opening, and ejection, but not cure.

Specifications are reported as follows:	
Press stroke, in.	5
Capacity, tons	25
Ejection stroke, max. in.	2.5
Hold-down pin stroke, max. in.	1.25
Distance between platens, max. in.	22.5
Bed plate to ram, press closed, in.	12-17
Platen area, in.	6 x 11.5
Height, in.	84
Floor space required, in.	29 x 36
Gross weight, lbs.	1,100

Readers' Service Item E-5

Automatic Abrasion Tester

An automatic abrasion tester for plastics, rubber, coatings, linoleum, leather, metals, and textiles has ben introduced by Tabor Instrument Corp. Designated Model 174, the unit has dual abrading wheels transversing a 360° circle on the test specimen. The left wheel rubs from the outside in toward the center, and the right wheel rubs from the center outwards to produce criss-cross abrading lines. This assures greater accuracy with respect to weave, grain, and pattern.

Dimensions of the main unit are 20 by 14 by 10 inches high, and net weight of the set is approximately 100 pounds. The test set includes the following items of equipment: abraser with built-in automatic counter and stop switch; two 1,000-gram weights; two 500-gram weights; two specimen holders; a hold-down ring; hex wrench; 1,000 abrasive discs for refacing wheels; hand brush; 10 specimen plates; two sets of two Calibrase wheels; two sets of two Calibrade wheels; a vacuum unit; clean-up brush; electrical attachment cord; and an instruction manual .

Model 174 abrasion tester. The standard Model 133 wheel refacer is in foreground.

Readers' Service Item E-6

Pleasing Odor = More Sales

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A soft talc odor helps sell baby pants. A soap-fresh fragrance adds buy-appeal to shower curtains. Hand bags with a simulated leather odor have a real competitive advantage.

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SINDAR® Corporation

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New Products

Styrene foam figurines bonded with Styrogrip.

Adhesive for Foamed Styrene

A colorless, resin-solvent adhesive for bonding foamed polystyrene to such materials as plywood, galvanized iron, concrete block, and to itself, has been introduced by Adhesive Products Corp. Designated 145-0 Styrogrip, the material is totally unaffected by immersion in water for 24 hours.

The solvent base is not only quick-drying, but does not attack the foam. Styrogrip has been used to adhere foamed insulations to refrigerators and freezers, and has wide applications in the fields of foam toys, ornaments, and display items.

Readers' Service Item P-1

SCOTT TESTERS* MODEL L-4

Model L-4 is world-standard for tensile tests on wire insulation and sections of cable jacket. It permits compliance with UL, ASTM, CSA and U.S. Government Specifications in the range 0-500 lbs.

Request Literature

* Trademark

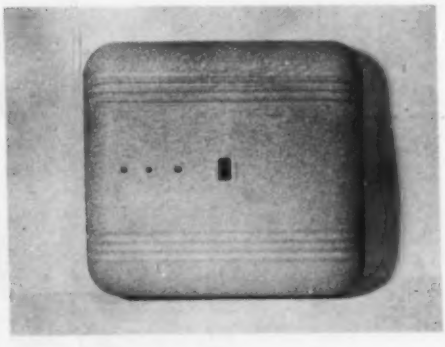
SCOTT TESTERS, INC.

149 Blackstone St., Providence, R. I.

Abrasion-Resistant Plastisol

A wrinkle plastisol, combining the resistance properties of vinyl with the decorative and abrasion-resistance features of wrinkle finishes, has been introduced by Stanley Chemical Co. A 100% solids material, the plastisol is expected to find wide usage as a finish for typewriters, business machines, and other mechanical devices.

Directions for application are as follows: The metal is freed of dirt, grease, and other foreign matter. Stanley Primer 40X-415, diluted 3:2 with Stanley Thinner 79R-192, is applied by air or spray. After the solvent evaporates, the object is baked for 20 minutes at 350° F. The plastisol, reduced approximately 10:1 with 79K-53 Thinner, is then applied by spray until a thickness of 8-10 mils is obtained. After air-drying for a minimum of 10 minutes, the article is returned to the 375° F. oven. Baking time depends on the size and weight of the object, but averages about eight minutes.



Stanley wrinkle plastisol finish.

Stanley wrinkle plastisol should be stored in a cool place, and kept tightly covered at all times. It is not recommended for outdoor exposure. Presently-available colors are black and gray, but other shades are being developed.

Readers Service Item P-2

Extruded High-Impact Sheet

Extruded styrene-copolymer sheet has been placed on the market by Campco division, Chicago Molded Products Corp. Designated Campco S-1029, the sheet is said to offer improved strength and color control over the previously available calendered sections. Thicknesses to 3/16-inch are available.

Outstanding feature of the sheet is its impact strength, even at very low temperatures. Free from internal strain, it is readily vacuum-formed into complex shapes. Properties ascertained by ASTM test methods are reported as follows:

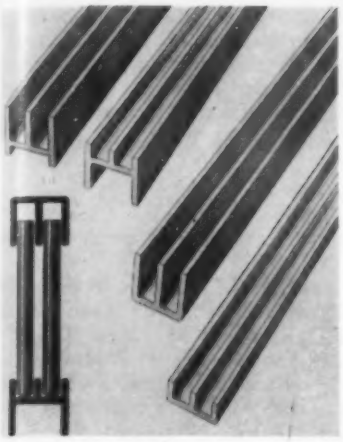
Extruded styrene-copolymer sheet retains impact strength at sub-zero temperatures.

Specific gravity	1.01
Water absorption, 24 hrs., %	0.28
Heat distortion, 66 psi., °F.	183
Tensile strength, psi	4,500
Elongation, %	100
Modulus of elasticity, psi. x 10^5	1.96
Flexural strength, psi.	6,800
Impact strength, notched Izod, ft.-lbs. @ 73° F.	4.8
At — 40° F.	1.6
Rockwell hardness, R scale	85

Readers' Service Item P-3

Extruded Impact-Styrene Track

Ancorene Tracks have been added to the line of plastic extrusions produced by Anchor Plastics Co. Extruded from high-impact, modified polystyrene, the tracks



Modified, high-impact styrene tracks.

provide runners for sliding glass doors, mirrors, and panels. They feature extreme durability, and will not chip, warp, splinter, or rust.

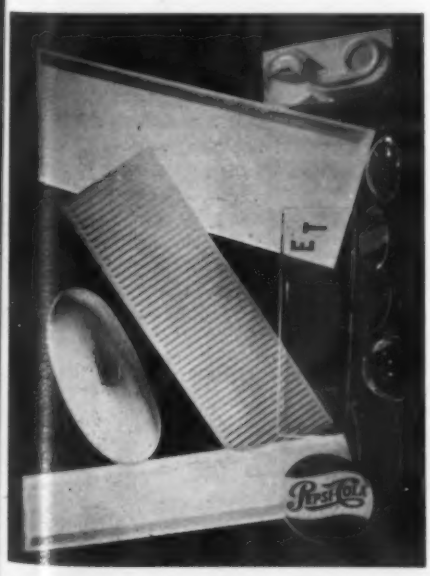
The tracks are constructed with special convex platforms to reduce friction, and provide effortless gliding ease without the use of rollers. Single, double, and triple tracks are available. Since the extrusions involve low-cost dies, special designs can be specified without increasing the ultimate cost. Color choice is unlimited.

Readers' Service Item P-4

Extruded Acrylic Sheet

An extruded acrylic sheet, reportedly offering substantial savings over cast sheet, has been developed by Cadillac Plastic & Chemical Co. Suitable for many industrial, fashion, and maintenance applications, the sheet is offered in clear and standard colors. Any quantity, from one sheet up, can be obtained; however, a minimum order of 1,000 pounds is required for non-standard colors.

The extruded sheet is exceptionally free of extrusion lines and other marks or blemishes. It holds close thickness tolerances, and gives minimum shrinkage at forming heats. Excellent weatherability is reported. Stock sheets measure 0.06-, 0.08-, 0.1-, and 0.125-inch thick; 49 inches in width. Lengths are cut to customer requirements.



Parts from Cadillac extruded acrylic sheet.

Readers' Service Item P-5

Alkyd-Base Tube Socket

A right-angle tube socket for horizontal mounting is being molded from Barrett's Plaskon alkyd resin by Wilcox Plastics, Inc., for distribution by Aerovox Corp. Designed for use with printed circuits, the right-angle sockets permit greater miniaturization and more compact packaging. This, in turn, permits the tubes to be placed closer to heat sinks.

Lower position of the tube mass reduces socket strain, which is caused by acceleration in the plane of the mounting surface. In most applications, the right-angle tube sockets permit easy tube replacement without component disassembly. The sockets are suited for manual or mechanized insertion into printed wiring boards utilizing in-line, punched, round holes. Loads are simply dropped in and soldered. Long terminals permit use with a wide range of printed wiring-board thicknesses.

Alkyd tube socket features right-angle mount.

Plaskon alkyd was selected for its superior properties of arc resistance, dielectric strength, dimensional stability, and resistance to heat and moisture. Contacts are silver-plated beryllium copper; mounting bracket, support, and shield are tin-plated steel. In addition to the standard sockets described above, the manufacturer supplies sockets with special mounting bracket and tube shield to resist shock and vibration.

Readers' Service Item P-6

NEW! DME STANDARD

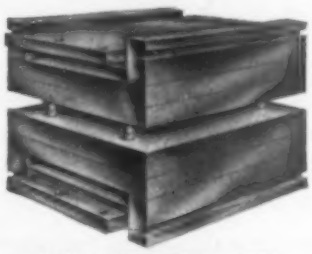
COMPRESSION MOLD BASES

"Tailor-Made" FOR STOKES MODELS 800 & 741 PRESSES

HERE'S ADDED SAVINGS AND TROUBLE-FREE PERFORMANCE FOR COMPRESSION MOLDERS..!

Available in D-M-E No. 1 or No. 2 Steel.
Cavity plates ground Flat and Square.
Complete range of Cavity Plate thicknesses.
Ready to install cavities or inserts.
Leader pins and bushings–Precision Ground.
Ejector bars drilled to suit K-O Rods.

D-M-E 611-C (6" x 10⅞")
For Stokes Model 800 Press



D-M-E 1315-C (13" x 15")
For Stokes Model 741 Press

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Branches in Hillside, N.J., Chicago, Ill., Cleveland, O. & Los Angeles, Calif.

New Literature

Write item numbers on Readers' Service card to obtain copies.

"Ethers and Oxides." F-4764. Carbide & Carbon Chemicals Co. 64 pages. This booklet covers applications for 32 products, including ethylene oxide and propylene oxide. Data includes physical properties, solubilities, shipping, specifications, and test methods. There are 34 charts in all.

Readers' Service Item L-1

"The New Stokes 2-Ounce Injection Molding Machine." Bulletin 565. F. J. Stokes Corp. 8 pages. Design features of the company's Model 701 automatic injection molding machine are described and illustrated in this bulletin. Close-up photographs show the automatic ejection and degating sequence, including the action of the separator plates. Complete specifications are listed.

Readers' Service Item L-2

"How to Choose an Extruder." Bulletin E-3. Prodex Corp. 46 pages. The various parts of an extruder are described in detail, such as gear transmission, flexible coupling and thrust assembly, feed section, cylinder, screw, length/diameter ratio, head and gate, control cabinet, etc. A number of schematic drawings are included.

Readers' Service Item L-3

"The Completely New Model CET." Scott Testers, Inc. 6 pages. This new tester is said to offer precise information on tensile strength, compression, and hysteresis in the range of 0-2,000 pounds. Other reported features include magnified stretch, variable speeds, selective picturization, infinitely variable load, and cyclic loading.

Readers' Service Item L-4

"Kel-F Fluorocarbon Products." M. W. Kellogg Co. 8 pages. Forms, properties, and applications, ranging from plastic resins to acids and dielectric fluids, are described in this brochure. Numerous illustrations are included.

Readers' Service Item L-5

"Fibercore Molding Compounds." Plumb Chemical Corp. Data sheets on the company's line of fibrous glass-reinforced polyester molding compounds are included in this flyer. The publication itself describes part and mold design, and explains shelf life.

Readers' Service Item L-6

"P-K Blending Equipment, Process Equipment, and Heat Exchangers." Patterson-Kelley Co., Inc. 16 pages. This profusely illustrated catalog covers the following equipment: twin-shell, double-cone, and ribbon blenders; synthetic resin pilot plants; heat exchangers; and lever-lock doors for pressure vessels and heat exchangers.

Readers' Service Item L-7

"Skin and Blister Packaging with Torriseal." Form No. B-1. Pierce & Stevens Chemical Corp. 4 pages. This bulletin describes the firm's two Torriseal adhesives used in skin and blister packaging: E-1303 for cellulosics; and C-9047 for vinyls. Properties, methods of application, drying schedules, and heat sealing methods are listed.

Readers' Service Item L-8

"Anti-Oxidant AC-1." Catalin Corp. of America. 8 pages. The anti-oxidant, 2,6-ditertiary-butyl-para-cresol, prevents oxidation in hydrocarbons such as gasolines, oils, waxes, polyethylene, and rubber. Properties are listed.

Readers' Service Item L-9

"Acetophenone." F-6970A. Carbide & Carbon Chemicals Co. 8 pages. Physical properties, shipping data, solubilities, typical reactions, and applications are listed for this aromatic ketone, which is used as a resin solvent and as an intermediate in the manufacture of styrene and other resins.

Readers' Service Item L-10

"Engineering Materials to Improve the Design and Performance of Your Product." National Vulcanized Fibre Co. 4 pages. This illustrated folder lists the properties and applications of the company's converted cotton cellulose and Phenolite laminated plastic. The firm's design and fabricating service also is described.

Readers' Service Item L-11

"Directory of Members of the American Standards Association." American Standards Association. 63 pages. The 115 national technical societies, trade associations and public interest groups are listed, together with the 2,300 companies affiliated with the ASA.

Readers' Service Item L-12

"New Horizons for Epon Resins." Shell Chemical Corp. 16 pages. Four applications for Epon, Shell's epoxy resin, are described and illustrated: airline food carrier trays, auto engine valve seat, washing machine prime coat, and aircraft tooling.

Readers' Service Item L-13

"Effect of Diameter on Rubber-Covered Squeeze Rolls." Report No. 10. Rodney Hunt Machine Co. 2 pages. Illustrated with graphs, this report covers deflection under various loads; how roll deflection affects performance across roll width; and the effect of roll diameter on nip width.

Readers' Service Item L-14

"Premix Compounding." Finishes division, Interchemical Corp. 23 pages. This brochure gives property data for the firm's line of polyester premix compounds, color concentrates, and parting agents. Suppliers of such accessory materials as catalysts, mold lubricants, molds & dies, presses, ovens, adhesives, reinforcements, and fillers are listed.

Readers' Service Item L-15

"Monomer Headquarters for the Resin Industry." F-40033. Carbide & Carbon Chemicals Co. 4 pages. This folder lists formulas, specific gravities, boiling points, and applications for 36 of the firm's monomer chemicals. General categories include acids, aldehydes, esters, ethers, nitrogen compounds, hydrocarbons, and salts.

Readers' Service Item L-16

Book Reviews

"Research on Boron Polymers." W. L. Ruigh, Wright Air Development Center. In three parts, PB 111689, PB 111892, and PB 121374. Order from OTS, U. S. Department of Commerce, Washington 25, D. C. Paper, 58, 85, and 47 pages, respectively. Prices, $1.50, $2.25, and $1.25.

Part I reviews the literature of the field, as determined by a three-months survey. This includes inorganic polymers, semi-organic polymers, polymers, rubber, and the chemistry of boron compounds. An initial discussion covers the preparation of polymeric boronamides derived from stabilized boronic acids and bifunctional isocyanates. Purpose of the over-all program was to isolate hydrolytically-stable polymeric materials with high fuel and oil resistance and good thermal stability.

Part II reports on the synthesis of quadricovalent chelate and quasi-chelate boronic acids and borates. The diethanolamine ester of benzeneboronic acid was prepared and found to be stable to hydrolysis. Allylboronic acid and esters were studied as intermediates for a dimethylaminopropane boronic acid and related compounds.

Part III describes a new, simple synthesis of boron-substituted alkyl and aryl borazoles in which an alkyl or aryl boron dichloride is reacted with ammonia. This synthesis is reportedly applicable to the preparation of boron-containing polymers. Benzeneboronic acid, tri-n-butylborine, butyl boron dichloride, and phenylboron dichloride were studied as intermediates for the synthesis. A new, catalytic recirculating apparatus for preparing phenylboron dichloride from benzene and boron trichloride by Pace's method is described.

"Development of an Organic Lacquer Resistant to Fuming Nitric Acid." F. J. Honn, R. E. Martin, and D. R. Wolf, Wright Air Development Center. Order PB 121205 from OTS, U. S. Department of Commerce, Washington 25, D. C. Paper, 46 pages. Price, $1.25.

Polychlorotrifluoroethylene (Kel-F) was modified in an attempt to develop a resin coating which would be resistant to white fuming nitric acid (WFNA), encountered by metals in jet aircraft compartments. Kel-F met all requirements for resistance to WFNA in acid tanks and assisted take-off compartments of B-47 aircraft. Difficulties arose, however, in its application to aluminum structures. Kel-F was then modified by copolymerization with vinylidene fluoride. This copolymer, known as X-200, is a filleting material and lacquer. Aluminum coatings were found adequate, and resistance superior to WFNA was reported.

"Development of Electronically-Conductive Transparent Coatings for Acrylic Plastic." M. A. Coler, A. S. Louis, and J. C. Kalbach, Wright Air Development Center. Order PB 121208 from OTS, U. S. Department of Commerce, Washington 25, D. C. Paper, 92 pages. Price, $2.50.

The Marklad process, which involves repeated contact between a plastic surface coated with a transferable conductor, was adapted to the application of transparent, static-dissipating coatings to acrylics. Flat sheets showed resistance of 1-10 megohms, light transmission of 75-85%, and haze of 1-2.5%. Procedures were extended to include curved surfaces.

"Chemical Market Research in Practice." Edited by Richard E. Chaddock. Reinhold Publishing Corp., 430 Park Ave., New York 22, N. Y. Cloth, 5¼ by 7¾ inches, 224 pages. Price, $3.00.

The material in this book is based on a series of 16 lectures presented at Case Institute of Technology, Cleveland, O., and in Wilmington, Del., through the Extension Division of the University of Delaware. Written by 22 experts, all members of the Chemical Market Research Association, the book deals with theoretical and practical aspects of chemical market research. All phases are covered from basic research through the end product.

Chapters are devoted to chemical market surveys; literature of the field; field work; integration of results into written reports, statistics, and charts; policy planning and finance; and departmental case studies. Of special interest to the plastics industry are the chapters covering the petrochemical industry; paint, varnish, and lacquers; synthetic fibers; and the plastics industry itself. This latter chapter presents a step-by-step method of surveying polystyrene production, producers, plant capacities, uses, distribution, and futures. Statistics are presented, together with a bibliography.

"The Development of Electrical-Conducting Transparent Coatings for Acrylic Plastic Sheet—Part II." G. A. Dalin and I. Flores, Wright Air Development Center. Order PB 121262 from OTS, U. S. Department of Commerce, Washington 25, D. C. Paper, 61 pages. Price, $1.75.

This report is a continuation of PB 121208, with a detailed description on preparation and application of silica undercoatings. Studies of sputtering of cadmium oxide films are extended, and coating techniques are applied to curved as well as flat surfaces.

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Abstracts of Important Articles

Materials

"Flow Behaviour of Thermoset Plastics in the Temperature Range 100-170° C. during Cure," R. Liedmann, *Plaste u. Kautschuk*, 3, 2, 27 (Feb. 1956).

It is shown that the empirical methods now in use are not suitable for determining flow properties of thermoset plastics. Instead, these properties are determined in absolute units (poises) with the aid of a plastometer arrangement which has provision for high frequency heating in addition to other heating. Mathematical calculations and measurements indicate how a molding process can be judged, and how the individual factors of temperature, molding time, structural viscosity, and molding pressure affect flow. (In German.)

"Determination of Second Order Transition Temperature of High Polymers," W. Griehl and R. Hoffmeister, *Plaste u. Kautschuk*, 3, 3, 53 (March 1956).

Description of a simple method of determining second-order transition temperature of plastics (specifically, modified polyethylene terephthalate) by means of the dielectric constant. (In German.)

"The Use of High Molecular Substances as Plasticizers," K. Thinius, *Plaste u. Kautschuk*, 3, 2, 33; 3, 3, 54; 3, 4, 78 (Feb., March, April 1956).

The preparation, applications, and action of high molecular weight plasticizers are reviewed. The discussions cover copolymers of butadiene-acrylonitrile, polymers of the vinyl series, polymeric esters and ethers, and others. A number of American, British, French, and German patents are referred to and listed. (In German.)

"Epoxy Resins for Correcting Casting Flaws," W. Schafer, *Plaste u. Kautschuk*, 3, 4, 85 (April 1956).

In the foundries of East Germany, a relatively large proportion of the castings produced is flawed. In order to render serviceable as many as possible, the Plastics Laboratory of the German Academy of Sciences, of Berlin, has been investigating the possibilities of correcting defects by filling porous areas, very fine and even fairly wide cracks, and large surface bubbles and cavities with coatings and pastes of epoxide resins mixed with powdered metal. The methods and materials are discussed. Though no conclusive data on the value or limitations of the processes are yet available, they have been publicized to insure their introduction as soon as feasible. (In German.)

"Plastics and Cable Making," H. Lemainque, *Ind. Plastiques Mod.*, 8, 4, 42 (April 1956).

This is a brief review of the problems encountered in the use of synthetic plastics in the manufacture of cables. The author calls attention to the trend of demand for plastics in cables, and makes some suggestions regarding the direction of research by cable manufacturers. (In French.)

"General Methods of Determining Weight and Dimensions of Macromolecules," Ch. Sadron, *Ind. Plastiques Mod.*, 8, 5, 43 (May 1956).

The determination of the structure of a macromolecule involves two types of investigation: (1) the usual chemical or spectrographic methods of studying molecules having a small number of atoms, aiming at establishing the relative positions of neighboring groups of atoms; and (2) morphological measurements aimed at obtaining a general picture of the macromolecular edifice. Both methods should be used at the same time, since conclusions based on results of either one aid in drawing conclusions from the other. The author discusses the various methods employed in macromolecular morphology in their application to the ideal case of a monodisperse system. (In French.)

"How to Pick the Right Polyethylene," E. T. Darden and C. F. Hammer, *Materials & Methods*, 44, 3, 94 (Sept. 1956).

A description of melt index, density, and molecular weight distribution of polyethylenes, and their influence on engineering properties of the materials.

"Service Temperature Characteristics of Molded Acrylic Parts," J. J. Gouza and E. N. Robertson, *SPE J.*, 12, 9, 19 (Sept. 1956).

Data are presented to point up the major temperature limitations of Grades 6 and 8 acrylic molding powder. Highest resistance to service temperatures is obtained with Grade 8 material, regardless of the molding conditions. Maximum permissible service temperature of a part will depend on the shape of the part, the imposed stress, length of stressing time, and the desired service life.

"On the Suitability of Tetralkyl Silicates as Adjuncts in Processing High Polymers," K. Thinius, *Plaste u. Kautschuk*, 3, 1, 1 (Jan. 1956).

Tests were carried out to discover the solvent and plasticizing effect of tetralkyl silicates on high polymers. Tetramethyl silicate, a medium high-boiling solvent, has lower solvent power than butyl acetate, but stored solutions remained stable for three months (testing was discontinued after this time). It dissolves nitrocellulose, ethyl cellulose, some acrylic esters, PVA, alkyd resins, modified phenol resins, and coumarone resins. Tetrabutyl and tetradodecyl silicates have no solvent effect, nor are they useful as plasticizers. However, the solvent action can be improved by the introduction of negative substituents in the alcohol residue. Tetrahydrofurfuryl silicate dissolves PVC, but yields unsatisfactory films. A mixed ester was prepared from tetrahydrofurfuryl alcohol, glycol and tetramethyl silicate. When used as plasticizer for PVC, resultant films broke after 48 hours storage at room temperature. (In German.)

"Durability of Modified Polystyrenes," L. Gilman, K. T. Carolan, and Milton Resnick, *Modern Plastics*, 34, 1, 176 (Sept. 1956).

Results of 3-three outdoor exposure tests show considerable differences in initial properties and durabilities of polystyrenes modified with GR-S and nitrile rubber.

Equipment

"The Impact Test in the Examination of Plastics," W. Spath, *Gummi u. Asbest.*, 9, 2, 62 (Feb. 1956).

After discussing questions of strength of materials and measuring techniques that arise during impact tests with pendulum testers, a new "slow impact tester" is described which is claimed to combine the advantages of the static load test and the impact test. A relatively simple device permits measurement of maximum load, as well as the impact energy. By retarding the stroke, falsification of results due to centrifugal energy is avoided. Tests on various plastics are described. (In German.)

Processing

"New Methods in the Manufacture of PVC Pastes," T. Hugosson, *Kunststoffe*, 46, 7, 341 (July 1956).

According to a Swiss patent, very low viscosity pastes are obtainable when coarse and fine fractions of the same PVC powder and plasticizer are mixed. In the Stockvikwerk Sweden, research has shown that by varying the proportions of two such fractions, pastes of any viscosity can be obtained from the same polymer containing the same amount of plasticizer. Varying the ratio of coarse to fine fraction affects storing qualities; a preponderance of the former leading to a far more rapid increase in viscosity than where the fine fraction is the larger. The hardness of the

gelled pastes varies with plasticizer content. The pastes can be cast or spread on fabrics and paper, and perfectly transparent products are obtainable. No special apparatus is required for mixing but like other PVC pastes, these two-fraction pastes must be milled to make them perfectly homogeneous before casting or spreading. Air also must be removed, and for these pastes are more easily accomplished by vacuum suction than for most other PVC pastes. (In German.)

"Electronic Welding in Garment Manufacture," J. Blond, *Ind. Plastiques Mod.*, 8, 3, 1 (March 1956).

Rainwear, baby pants, garment bags of PVC are usually made currently by electronic welding of seams. The equipment required for a factory with a weekly capacity of 2,000 garments is described, and the operations in which specific machines and electrodes are used are given with their costs. The production of work and sporting clothes from single- and double-coated fabrics also is mentioned. (In French.)

Applications

"Reinforced Plastic Springs," F. W. Reinhart and S. B. Newman, *SPE J.*, 12, 8, 11 (Aug. 1956).

Results are given of tests on helical plastic springs formed from glass-reinforced epoxy resins cured with m-phenylenediamine. Results indicate that polyester and epoxy resins are most promising for spring applications on the basis of torsional moduli and temperature sensitivity.

"Plastics Pipe," R. T. Bogan, *Materials & Methods*, 44, 2, 100 (Aug. 1956).

A comparison of seven major types of plastic pipes with metal pipe. The plastic pipes are polyethylene, styrene copolymer, PVC, glass-reinforced polyester, asbestos-filled phenolic, butyrate, and vinylidene.

"Suitable Design as the way to Increase the Application of Plastics," H. Bischoff, *Plaste u. Kautschuk*, 3, 1, 17 (Jan. 1956).

Correct design of plastic parts which takes into account the limitations of the material is compared with improper design methods to illustrate that inappropriate design jeopardizes the strength and usefulness of plastic goods and discourages potential consumption. (In German.)

"Critical Study of the Practical Value of a Connection for Sub-Surface Polyethylene Piping," M. Delattre, *Ind. Plastiques Mod.*, 8, 5, 6 (May 1956).

The factors determining the choice of a connection for polyethylene piping are: anchorage and tightness; simplicity in use; lightness; resistance to corrosion; and price. The author considers these points and describes two types of tests for anchorage and tightness. He critically examines the different jointing systems currently in use, among others a British method for coupling of metal. Finally, he describes a French coupling made of very high-impact polystyrene which is designed to be used for plastic-to-plastic as well as plastic-to-metal assembly, and carries the same guaranty as polyethylene piping. (In French.)

"Some Dangerous Contacts between Rubber and Plastics in Electrical Cables and Wires," M. Hocquart, *Ind. Plastiques Mod.*, 8, 5, 41 (May 1956).

The dangers which may arise due to migration of plasticizers, stabilizers, and antioxidants when rubbers come in contact with plastics in electrical insulations and how this can be avoided, are briefly discussed in the specific cases of: PVC covers on rubber and on polyethylene insulations; synthetic on natural rubber; protective coatings on PVC and rubber; and impregnation of enameled wire coils. (In French.)

Request for copies, reprints, or further information on any article abstracted in this department should be addressed to the publisher of the magazine where the article appeared. The publishers and their addresses are given below:

"ASTM Bulletin"
American Society for Testing Materials
1916 Race St., Philadelphia 3, Pa.

"Australian Plastics"
Australian Trade Publications, Ltd.
171 Sussex St., Sydney, Australia

"British Plastics"
Iliffe & Sons, Ltd.
Dorset House, Stanford St.
London S.E.1, England

"Canadian Plastics"
341 Church St., Toronto, Ont., Canada

"Chemical and Engineering News"
1155 Sixteenth St. N.W.
Washington 6, D. C.

"Hule Mexicano y Plasticos"
Filomeno Mata 13-11, Mexico, D.F.

"Industrial and Engineering Chemistry"
1155 Sixteenth St. N.W.
Washington 6, D. C.

"Industries des Plastiques Modernes"
Les Publications Techniques Associees
40 Rue du Colisee, Paris 8e, France

"Kunststoffe"
Carl Hanser Verlag
Leonard Eck Str. 7, Munich 27,
Germany

"Kunststoff-Rundschau"
Brunke Garrels, Verlagsbuchhandlung
Borgfelder Strasse 83, Hamburg 26,
Germany

"Materials and Methods"
Reinhold Publishing Corp.
430 Park Ave., New York 22, N. Y.

"Materie Plastiche"
Via Farneti 8, Milan, Italy

"Matiéres Plastiques"
Galerie du Center, Bloc 3
Rue des Fripiers, Brussels, Belgium

"Mechanical Engineering"
American Society of Mechanical Engineers
29 W. 39th St., New York 18, N. Y.

"Modern Plastics"
575 Madison Ave., New York 22, N. Y.

"Oesterreichische Plastic-Rundschau"
Ployer & Co.
Aegidiengasse 5, Vienna 6, Austria

"Plaste und Kautschuk"
Veb Verlag Technik
12 Unter den Linden
Berlin N.W.7, Germany

"Plastic"
Danish Technical Press
31 Vester Farimogsgade
Copenhagen 5, Denmark

"Plastica"
Kunststoffeninstituut T.N.O.
Julianalaan 134, Delft, The Netherlands

"Plastics"
Temple Press, Ltd.
Bowling Green Lane, London E.C.1,
England

"Plastics World"
Cleworth Publishing Co., Inc.
22 W. Putnam Ave., Greenwich, Conn.

"Plastiques Informations"
94 Rue Saint-Lazare
Paris 9e, France

"Plastverarbeiter"
Verlagsgec. m.b.H.
Herxheim b. Landau/Pfalz, Germany

"Poliplasti"
E.T.A.S., Via Andrea Mantegna 6,
Milan, Italy

"Revista de Plasticos"
Inst. "Alonso Barba"
Serrano 119, Madrid, Spain

"Revue Générale des Matiéres Plastiques"
196 Ave. Jean-Jaures, Paris 19e, France

"Rubber and Plastics Age"
Rubber and Technical Press, Ltd.
Tenterden, Kent, England

"SPE Journal"
Security Bank Bldg., Athens, Ohio

"Transactions of the Plastics Institute"
The Adelphi, Adam St.
London W.C.2, England

Patent Digest

Materials

Selective Phenol-Aldehyde Resinification. No. 2,750,354. John H. Merriam, Cheltenham Township, Montgomery County, Pa. (to Allied Chemical & Dye Corp., New York, N. Y.).

A phenol and a formaldehyde are reacted in the presence of a resinification catalyst at a temperature of at least 65° C. Resin particles are withdrawn from the bottom of the reaction vessel as they settle.

Method of Preparing Melamine-Formaldehyde Resins, Including Vacuum Dehydration. No. 2,750,355. Howard Patrick Ledden, Old Greenwich, Conn. (to American Cyanamid Co., New York, N. Y.).

Fast-curing thermosets are prepared by reacting melamine and formaldehyde in a mol ratio of 1:1.5-1:2.5, dehydrating the condensation product by heating under a vacuum. An acid with a dissociation constant greater than 1 x 10^{-5} and an alkyl alkylol tertiary amine are added, and the mixture is dried to molding plasticity.

Compositions Comprising Polyester Plasticizers. No. 2,749,329. John L. Ludlow, Wilmington, Del. (to E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.).

The plasticizer is a polyester of adipic acid with an acid number below 21, an inherent viscosity of 0.03-0.131, and a hydroxyl number not greater than 15.

Synthetic Linear Polyamides Obtained by the Base-Catalyzed Polymerization of Unsaturated Amides. No. 2,749,331. David S. Breslow, New Castle County, Del. (to Hercules Powder Co., Wilmington, Del.).

An amide is polymerized under substantially anhydrous conditions, using a strongly basic catalyst.

Dispersion Polymerization Process for Tetrafluoroethylene. No. 2,750,350. Adam Edgar Kroll, Kennett Square, Pa. (to E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.).

Tetrafluoroethylene is polymerized in an aqueous medium in order to obtain a colloidal dispersion. The medium is acidic, and a water-soluble dispersing agent is added, together with a water-soluble peroxy compound of a saturated, aliphatic, dibasic acid. Powdered iron is then added, not exceeding 10 parts per million by weight of water present.

Compositions, Including Polystyrene and Terphenyl. No. 2,750,349. David Hale O'Herren, Indianapolis, Ind. (to Radio Corp. of America, New York, N. Y.).

The molding compound consists of 67.8-93% polystyrene, 1-25% resinous copolymer of styrene and butadiene, 0.5-3% metal soap, and 5-15% of a terphenyl material.

Process for Preparing Continuous Plastic Sheets. No. 2,750,320. Morton Elber Latham, Alhambra, Calif. (to Swedlow Plastics Co., Los Angeles, Calif.).

A flowable, polymerizable system is prepared containing ethylenically-unsaturated monomeric material, an acyloin, and an organic peroxide. The system is continuously encased in a flexible, translucent web and subjected to ultra-violet radiation.

Plasticized Vinyl Polymer Compositions. No. 2,750,351. Massimo Baer, Springfield, Mass. (to Monsanto Chemical Co., St. Louis, Mo.).

The vinyl chloride or vinylidene chloride compound is plasticized with the heat reaction product of a trialkyl phosphite and an allyl chloride polymer. Approximately 0.2-1 mol of combined phosphorus is added per mol of combined allyl chloride.

Polymeric Chlorotrifluoroethylene. No. 2,755,267. Robert W. Finholt, Erie, Pa. (to General Electric Co., Schenectady, N. Y.).

This solid composition contains polychlorotrifluoroethylene and 5-20% by weight of a chlorinated diphenyl ether.

Printed copies of patents are available from the Commissioner of Patents, Washington 25, D. C. Price, 25c each.
—The Editor

Polysulfone Stabilized with Hydrogen Sulfide-Vinylcyclohexene Reaction Product and Stabilized Polysulfone Product. No. 2,750,352. Robert J. Fanning, Bartlesville, and Asa Clarence Dees, Cushing, Okla. (to Phillips Petroleum Co., Bartlesville, Okla.).

A polysulfone resin is formed by reacting an unsaturated organic compound with sulfur dioxide which tends to decompose on heating and a reaction product of hydrogen sulfide and 4-vinyl-1-cyclohexene.

Resinous Condensation Products of Acetoacetic Esters and Unsaturated Aldehydes. No. 2,755,268. Heinz Uelzmann, Ludwigshafen, Germany (to Badische Anilin & Soda Fabrik Aktiengeselschaft, Ludwigshafen, Germany).

A resinous condensation product of an α, β-unsaturated aldehyde and a full acetoacetic acid ester of a saturated polyalcohol containing 2-4 hydroxyl groups.

Process for the Preparation of Polyvinyl Sulfonamide. No. 2,754,287. Harold F. Park, East Longmeadow, Mass. (to Monsanto Chemical Co., St. Louis, Mo.).

Vinyl sulfonamide is polymerized in a solution containing water and polar organic solvents at a temperature of 50-100° C., and at a pH of 6.5-7. The reaction takes place in the presence of a catalytic amount of a solvent-soluble, radical-generating polymerization catalyst.

Emulsions of Ionically Cross-Linked Resins and Methods for Making Them. No. 2,754,280. George L. Brown, Moorestown, N. J., and Benjamin B. Kline, Levittown, Pa. (to Rohm & Haas Co., Philadelphia, Pa.).

Dispersed throughout an aqueous medium are a non-ionic emulsifier, a water-insoluble copolymer containing an acrylic ester and carboxyl-containing acrylic monomers, and a basic metallic compound.

Polymerization of Tetrafluoroethylene with Tertiary Butyl Peroxide or Peracetate. No. 2,753,329. Adam Edgar Kroll, Kennett Square, Pa., and David Albert Nelson, Wilmington, Del. (to E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.).

This vapor-phase process for the polymerization of tetrafluoroethylene comprises the formation of a reaction mixture consisting essentially of monomeric tetrafluoroethylene and 0.00005-0.005 gram of ditertiary butyl peroxide or tertiary butyl peracetate per cubic centimeter of tetrafluoroethylene. This mixture is then subjected to a temperature of 100-300° C. at a pressure of at least 100 psi., and in the presence of not more than 0.001% by weight of uncombined oxygen. Fluidizable polytetrafluoroethylene powder with a screen size of about 325-mesh is recovered.

Production of Plasticizers. No. 2,754,321. Han Hoog, Amsterdam, and Peter Van't Spijker, The Hague, Netherlands (to Shell Development Co., San Francisco, Calif.).

Plasticizers are produced from a paraffinic wax by cracking under conditions which will give an olefinic product rich in alpha olefins. These materials are carbonylated, esterified, and separated by fractionation. Sulfuric acid, 1-4%, is added to a 92% concentration of the material and agitated to accomplish the fractionation.

Plasticized Compositions. No. 2,754,259. Max Henry Dilke, Coulsdon, Donald Faulkner, Epsom, and Sidney Merry, Edgware, England (to Distillers Co., Ltd., Edinburgh, Scotland).

The composition comprises a crystalline vinylidene chloride-vinyl chloride-diethyl maleate copolymer and gelatin. The latter is prepared in aqueous dispersion and mixed so that the final product contains 14% by weight of vinyl chloride and 2% by weight of dimethyl maleate. About 10% by weight of dimethyl phthalate is used for plasticizing the composition.

Plastic Compositions Containing Carbonato Nitriles. No. 2,755,264. William L. Riedeman, Philadelphia, Pa. (to Rohm & Haas Co., Philadelphia, Pa.).

A vinyl halide resin is plasticized with a carbonato nitrile of a fatty acid which contains 16-22 carbon atoms and 1-3 substituent carbonato groups.

Rigid Vinyl Halide Polymer Compositions Adapted for Vacuum Forming. No. 2,753,322. Clarence E. Parks, Bay Village, and Garland B. Jennings, Avon, O. (to B. F. Goodrich Co., Akron, O.).

Reported to be extremely shock-resistant, the thermoplastic sheet comprises an intimate mixture of rigid vinyl chloride homopolymer; a resinous polymer of a predominantly monoolefinic mixture comprising 50-90% styrene and 10-50% acrylonitrile; a rubbery interpolymer comprising 50-90% of a 1,3-butadiene hydrocarbon, 5-30% acrylonitrile, and 5-30% of another monoolefinic monomer; and a resinous interpolymer of vinyl chloride and vinyl ester.

Process of Forming a Condensation Product of an Alkyl Ether of Phenol and an Aldehyde and the Resulting Composition in Combination with Colloidal Silica. No. 2,753,316. Joseph A. Campbell, Manhattan Beach, Calif. (to X-Port Oils, Inc., Los Angeles, Calif.).

This high-strength, heat-resistant thermosetting resin consists of a liquid condensation product of a water-insoluble alkyl ether of phenol and an aldehyde. It contains about 15-35% by weight of an alkyl orthosilicate, a small amount of water, and more than 25% by weight of a saturated alcohol.

Copolymer of Trifluorochloroethylene and Isobutylene and a Method of Manufacturing Same. No. 2,753,328. William S. Barnhart, Cranford, N. J. (to M. W. Kellogg Co., Jersey City, N. J.).

Substantially equal mole amounts of trifluoroethylene and isobutylene in admixture with 50 parts of water and 0.1 parts of potassium persulfate are polymerized at a temperature of 50° C. for 60 hours. The copolymer contains about 20% chlorine and about 32% fluorine.

Process of Polymerizing α-Chloroacrylic Acid Esters in Contact with a Vitreous Surface and in the Presence of an Oily Siloxane Polymer. No. 2,752,638. Harry D. Anspon, Easton, Pa. (to General Aniline & Film Corp., New York, N. Y.).

Sheets of polymeric methyl α-chloroacrylate are cast by mass polymerization between spaced glass plates, having first incorporated 0.005-0.1% by weight of an oily methyl phenyl siloxane polymer.

Dispersions and Use Thereof. No. 2,753,317. Boynton Graham, Claymont, Del. (to E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.).

The dispersion consists of an undissolved acrylonitrile polymer in an aqueous solution of an iron halide, wherein the halogen has an atomic number of 17-53. The iron halide forms a hexahydrate at 25° C.

White or Pastel-Pigmented Vinylidene Chloride Copolymer with Improved Color Retention Properties. No. 2,753,321. Austin L. Jankens, Bay City, Mich. (to Dow Chemical Co., Midland, Mich.).

The thermoplastic composition consists of vinylidine chloride, a plasticizer, an organic light stabilizer for the polymer, a small amount of pigment, 0.1-2% of a basic salt of an oxyacid of phosphorus, and 0.05-1% of a color stabilizer selected from the group consisting of aliphatic di- and tricarboxylic acids and their anhydrides.

Equipment

Apparatus for Simultaneously Advancing and Working Plastic Material. No. 2,752,633. Edward W. Weitzel, Hickory, N. C. (to Western Electric Co., Inc., New York, N. Y.).

The apparatus comprises an elongated extruding cylinder with imperforate cylindrical bore. A single stock screw with a helical thread mounted concentrically within the bore rotates about the longitudinal axis. A series of unribbed, tubular liners mounted end-to-end in the compound-working portion of the bore form a continuous passage. One of these liners has an interior bore extending eccentrically with respect to the stock screw. This provides a means whereby a plastic material is subjected to turbulent mixing and shearing as it advances through the working zone.

Mold for Thermoplastic Materials. No. 2,752,632. Thomas W. Winstead, Baltimore, Md. (to Hedwin Corp., Baltimore, Md.).

This embossing roll for continuously forming thermoplastic sheets with predetermined relief characteristics comprises a cylindrical core; a continuous, seamless, electroplated surface on the periphery of said core; a facsimile forming pattern; lateral portions extending around the core and forming selvage producing areas; and lateral, peripheral shoulders delimiting the pattern area and supporting the core.

Dispensing Device for Plastic Materials and the Like. No. 2,755,003. William A. Sherbondy, Cleveland, O.

The material-containing cartridge consists of a tubular body, a spout with dispensing passage and laterally-flexible flange, and an end-wall member with passage which emits the plastic material. The latter can be closed to preclude oozing during periods of non-use.

Injection Machine. No. 2,754,545. James W. Hendry, Bay City, Mich. (to Tube Turns Plastics, Inc., Louisville, Ky.).

The machine has a ram chamber, a preplasticizing unit, a reservoir within the ram, a passageway through the working face of the ram, a second passageway through the side of the ram chamber, one through the side of the ram, a communication means between the discharge end of the preplasticizing unit, and a reservoir plunger.

Film Extrusion Die. No. 2,754,544. Leo B. Bicher, Jr., Hackensack, N. J. (to E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.).

The die comprises a front block; two spacer plates and a rear block in juxtaposition, hollowed out to define a reservoir; entrance and exit passages; and an elongated, rectangular orifice with vertical grooves in the lip. Two of these grooves communicate with the upper reservoir, and the front block carries two bead-controlling members which extend into the lower end of their respective grooves. Two, vertically-adjustable dam members with curved-bottom doctoring surfaces to control the flashing beyond said grooves of an extruded film.

Current Market Prices

Price Changes and Additions

Colors

Claremont 4000-Series Pastes:			
Blacks	lb.	$0.82 /	$1.01
Blue	lb.	.80	
Browns	lb.	.65 /	2.30
Greens	lb.	.80 /	2.15
Orange	lb.	1.58	
Reds	lb.	5.60 /	6.95
Silver	lb.	1.02	
White	lb.	.715	
Yellows	lb.	.65 /	2.87
PE-Series, granular concentrates:			
Blacks	lb.	.86 /	1.05
Blues	lb.	2.98	
Green	lb.	3.00	
Metallics	lb.	1.27 /	1.66
Oranges	lb.	1.12 /	2.75
Reds	lb.	1.93 /	5.25
Whites	lb.	.70 /	.85
Yellows	lb.	.78 /	5.10

VC-Series Inks:			
Black	lb.	.94	
Blue	lb.	1.20	
Clear	lb.	.49	
Green	lb.	1.30	
Metallics	lb.	1.09 /	1.45
Orange	lb.	.95	
Pearl	lb.	1.45	
Red	lb.	1.05	
White	lb.	.70	
Yellows	lb.	.85 /	.98

Resins & Molding Compounds

Polyethylene		
Poly-Eth Hi-D 2504	lb.	.47

Names in the News (Cont'd from pg. 331)

Harold K. Latourette has been appointed exploratory section supervisor, organic chemistry department, at Food Machinery & Chemical Corp.'s newly-opened research center in Princeton, N. J. **Charles F. Ferraro** has been named a polymer-application research chemist in the plastics and polymers department, and will be in charge of the physical testing laboratories. **Borivoj R. S. Franko-Filipastic** has been appointed process section supervisor for the organic chemistry department.

Carroll A. Hochwalt, vice president in charge of research, development, and engineering for Monsanto Chemical Co., has been named winner of the 1956 Midwest Award of the American Chemical Society's St. Louis Section. Dr. Hochwalt is the twelfth recipient of the Award, which is conferred annually on a Midwestern scientist for "meritorious contributions to the advancement of pure or applied chemistry or chemical education."

Peter Dornil, Jr., has been appointed field service supervisor for technical service at Spencer Chemical Co., Kansas City, Mo. He previously served as development engineer at U. S. Rubber, and as senior technical service representative at Spencer.

John Schmidt has been elected vice president in charge of sales for New Plastic Corp., Los Angeles, Calif. With the firm for over 15 years, Mr. Schmidt has served as plant superintendent, division engineer, chief engineer, and sales manager of the tool division.

E. W. Maass has been appointed New England sales representative for Camin Laboratories, Inc., Brooklyn, N. Y., manufacturer of electroformed cavities.

Walter H. Meyer has been appointed sales manager of Logo, Inc.'s vacuum plating division. He will supervise field development and sale of Logo vacuum metallizing finishes.

Martin Rosen has been appointed technical director of both Kaye-Tex Mfg. Corp., Yardville, N. J., and its subsidiary, Kaykor Industries. Mr. Rosen formerly served as chief chemist and technical salesman.

Robert Shreve has been transferred from General Mills' O-Cel-O division to the Minneapolis research laboratory, where he will serve as section leader in the chemical engineering department. He also has been associated with American Viscose Corp. **Heinz Arnold** has joined the chemical research department as a chemist in product applications. **Howard Meindl** joins the department as a chemical engineer.

A. David Evans has been appointed St. Louis district sales manager of Monsanto Chemical Co.'s organic chemicals division, succeeding the late **B. Baxter Pearson. H. James Lawler,** manager of paper chemicals sales, replaces Mr. Evans as manager of resin materials sales. **Lloyd L. Shand,** assistant manager, takes over managership of the paper chemicals sales.

William L. Moore has been appointed sales engineer for U. S. Rubber's Royalene plastic products in the upper New York and New England areas. **Joseph P. Clancy** will handle similar functions in the middle Atlantic States, and **Donald F. Mirricleo** will be sales engineer in northern Illinois, eastern Iowa, Wisconsin, and Minnesota. The latter replaces **James H. McFarland,** who has been transferred to a West Coast territory.

John R. Davis has joined the polymer chemicals division of W. R. Grace & Co., and will be affiliated with top management at the polyolefin plant in Baton Rouge, La. He previously served as assistant department manager of Shell Chemical's Houston, Tex., plant.

Positions Open

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Domestic Production and Sales of Plastics and Resin Material, July and August, 1956

Following are the partly estimated and revised statistics for the domestic production and sale of plastics and resinous material during the months of July and August, 1956. Units listed are in pounds, dry basis unless otherwise specified. Data on alkyds and rosin modifications have not been included since their use is primarily limited to the protective coating industry.

Very appreciable gains are evidenced in all categories, with vinyls and phenolics leading the way. Over-all figures are up about 18%.

	July		August	
	Production	Sales	Production	Sales
Cellulose Plastics:[2]				
Cellulose acetate and mixed ester:				
Sheets, under 0.003 gage	1,111,937	1,331,082	1,786,688	1,600,604
Sheets, 0.003 gage and over	817,205	1,177,935	1,513,899	1,486,429
All other sheets, rods, and tubes	425,686	510,123	514,580	537,029
Molding and extrusion materials	5,872,025	5,769,005	7,394,790	7,697,619
Nitrocellulose sheets, rods, and tubes	344,008	322,601	443,064	376,011
Other cellulose plastics	369,684	261,947	554,455	459,330
TOTAL	8,940,545	9,372,693	12,207,476	12,157,022
Phenolic and Other Tar-Acid Resins:				
Molding materials[3]	13,454,700	13,020,293	16,113,590	13,730,256
Bonding and adhesive resins for—				
Laminating (except plywood)	3,929,177	2,618,835	4,782,947	3,640,002
Coated and bonded abrasives	1,030,530	1,240,514	841,039	752,970
Friction materials (brake linings, clutch facings, and similar materials)[7]				
Thermal insulation (fiber glass, rock wool)	4,436,354	4,775,895	4,401,617	4,028,950
Plywood	2,639,811	2,057,243	3,746,527	3,143,486
All other bonding and adhesive uses	3,414,006	3,474,753	4,300,979	3,660,109
Protective-coating resins, unmodified and modified except by rosin	1,793,090	1,881,617	2,361,017	1,694,502
Resins for all other uses	2,302,347	2,104,666	3,639,087	3,142,444
TOTAL	33,000,015	31,173,816	40,186,803	33,792,719
Urea and Melamine Resins:				
Textile-treating and textile-coating resins	2,386,109	2,976,723	2,653,805	2,711,390
Paper-treating and paper-coating resins	1,411,210	1,450,825	1,748,087	1,666,486
Bonding and adhesive resins for—				
Plywood	6,633,016	6,632,443	8,003,725	8,085,684
All other bonding and adhesive uses, including laminating	1,314,221	1,475,584	1,714,574	2,143,918
Protective-coating resins, straight and modified	2,195,973	2,019,916	2,816,943	2,365,834
Resins for all other uses, including molding	4,156,765	5,993,448	7,050,764	7,352,212
TOTAL	18,097,294	20,548,939	23,987,898	24,325,524
Styrene Resins:				
Molding materials[3]	34,154,183	27,254,254	34,519,055	31,072,856
Protective-coating resins, straight and modified	5,977,757	6,462,764	6,400,596	7,153,740
Resins for all other uses	7,123,267	7,118,459	9,768,958	9,701,051
TOTAL	47,255,207	40,835,477	50,688,609	47,927,647
Vinyl and Vinyl Chloride Resins:[3]				
Polyvinyl chloride and copolymer resins (50% or more PVC) for—				
Film (resin content)		4,722,110		6,497,296
Sheeting (resin content)		3,713,711		4,786,967
Molding and extrusion (resin content)		15,202,667		17,489,758
Textile and paper treating and coating (resin content)[8]		4,297,507		5,727,452
Flooring (resin content)		4,230,638		6,797,597
Protective coatings (resin content)		2,680,701		2,415,731
All other uses (resin content)		2,321,487		7,227,733
All other vinyl resins for—				
Adhesives (resin content)		3,164,936		3,256,792
All other uses (resin content)		8,145,830		9,213,204
TOTAL	49,750,804	48,479,587	57,051,221	63,411,530
Coumarone-Indene and Petroleum Polymer Resins	19,241,429	19,066,470	22,755,324	22,466,719
Polyester Resins	5,640,703	5,464,201	6,633,774	5,355,020
Polyethylene Resins	45,998,123	39,138,484	49,790,470	44,753,951
Miscellaneous Synthetic Plastics and Resin Materials:				
Molding materials[1,4]	2,840,927	2,586,244	3,258,996	3,381,000
Protective-coating resins[5]	844,338	438,972	1,033,078	480,817
Resins for all other uses[6]	8,898,594	7,972,666	9,881,302	9,382,856
TOTAL	12,583,859	10,997,882	14,173,376	13,244,673
GRAND TOTALS	240,507,979	225,077,549	277,474,951	267,434,805

[1]Includes fillers, plasticizers, and extenders.
[2]Production statistics by uses are not representative, as end use may not be known at time of manufacture.
[3]Includes data for spreader and calendering-type resins.
[4]Includes data for acrylic, nylon, silicone, and other molding materials.
[5]Includes data for epichlorohydrin, acrylic, silicone, and other protective-coating resins.
[6]Includes data for acrylic, rosin modifications, nylon, silicone, and other plastics and resins for miscellaneous uses.
[7]Included with "All other bonding and adhesive uses."
SOURCE: United States Tariff Commission, Chemical Division.

CALENDAR of COMING EVENTS

January 2
SPE Western New England Section. Bradley Field, Windsor Locks, Conn.

January 3
SPE Southern California Section. Scully's Restaurant, Los Angeles, Calif.

January 8
SPE Baltimore-Washington Section. Langley Park Hot Shoppe, Takoma Park, Md.

SPE Milwaukee Section. Bavarian Club, Milwaukee, Wis.

January 9
SPE Newark Section. Combined meeting with New York. Military Park Hotel, Newark, N. J.

January 11
SPE Connecticut Section. Hotel Barnum, Bridegport, Conn.

SPE Northern Indiana Section. Chamber of Commerce, Fort Wayne, Ind.

January 14
SPE Cleveland-Akron Section. Spanish Tavern, Brecksville, O.

January 16-18
SPE Thirteenth Annual Technical Conference. Hotel Sheraton-Jefferson, St. Louis, Mo.

February 1
Detroit Rubber & Plastics Group. Winter Meeting.

April 3
SPE New York Section. Regional Technical Conference. Plastics for Building. Hotel Statler, New York, N. Y.

April 4-5
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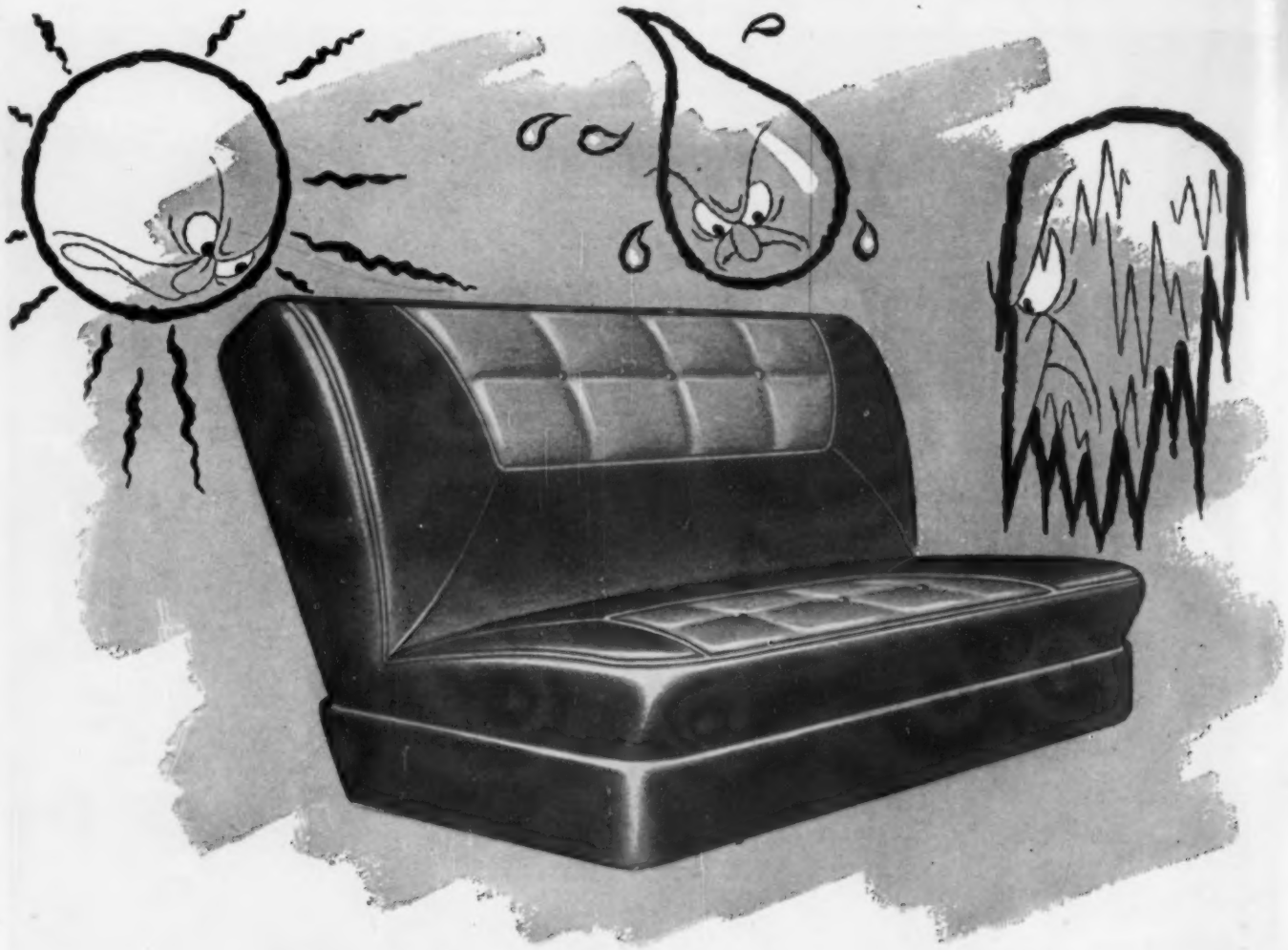

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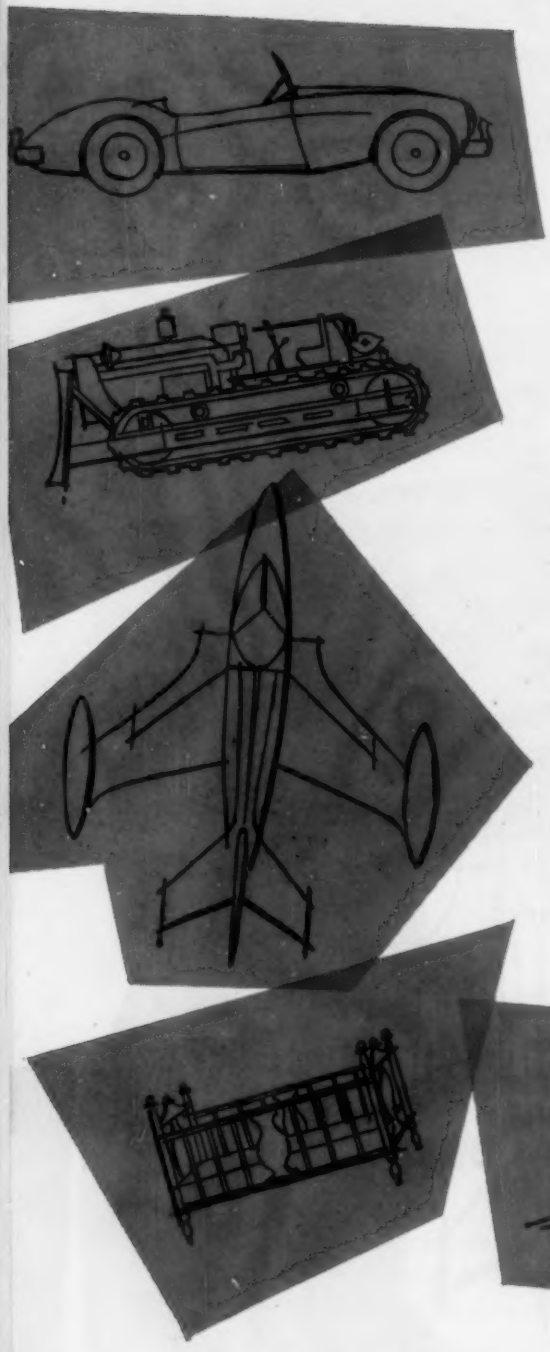

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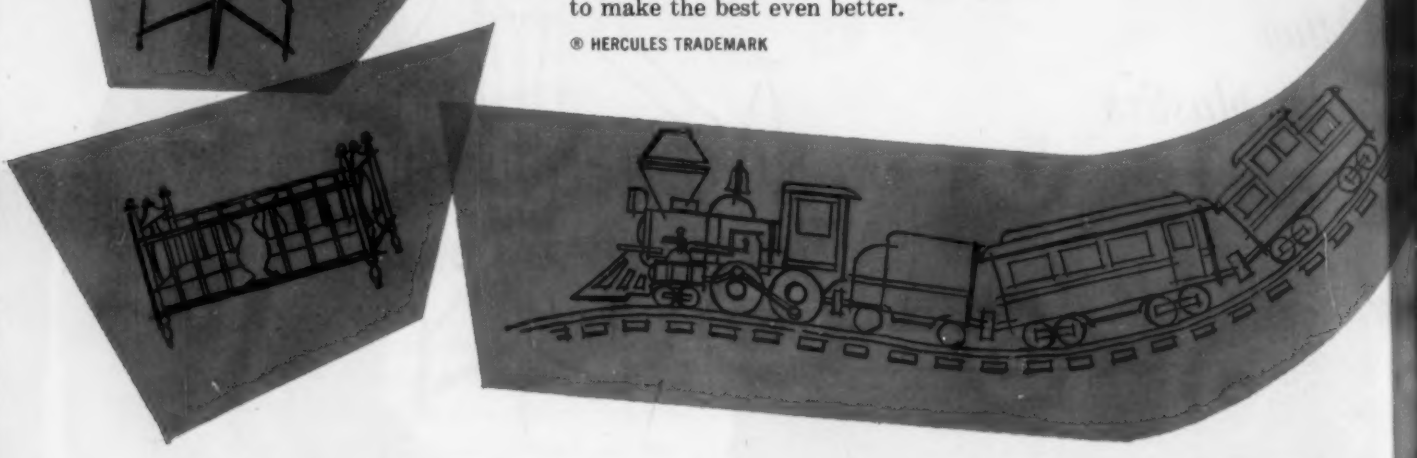

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Betsy Wetsy, long a favorite of small girls, poses with her brand new big sister—The Revlon Doll—"The Most Beautiful Doll in the World." Both of these dolls have a lot in common. For one thing they belong to the famous Ideal Toy Corporation family. For another, they both rely in part for their long-wearing durability on Hercules Hercocel (cellulose acetate). Betsy's head is completely Hercocel as are the soles of her big sister's shoes. Many toy manufacturers have come to count on Hercocel for acetate's famed toughness, whether it is needed for a complete product or just a crucial part. (Dolls courtesy Ideal Toy Corp., 200 Fifth Avenue, New York 10, N. Y.)

Cellulose Products Department

HERCULES POWDER COMPANY

INCORPORATED

958 Market St., Wilmington 99, Del.

EWER REJECTS—HIGHER RESIDUAL STRENGTH PROVED

...in production run of Vacuum Formed Door Liners with

MONSANTO LUSTREX Styrene Plastic

Here is a doubly critical operation of sheet extrusion and final vacuum forming of impact-proof refrigerator door liners. Quality requirements for these finished liners are high! The raw material must extrude sheets that are easily vacuum formed into complex die shapes. At the same time, cycles must be rapid. The refrigeration end use requirement demands an odor-free styrene. But most important, high vacuum forming temperatures cannot affect basic strength of the finished door liners! These are rigid specs for any material.

In a recent run of 7,350 liners, Lustrex Hi-Test 88B met and exceeded these requirements. Paul Schmidt, Chief Thermoplastic Engineer of the Panelyte Division of St. Regis Paper Co., reports, "Working with extremely complex dies, sheets extruded from Lustrex Hi-Test 88B give us excellent resilience and constant flow regardless of high heat cycles ranging from 350°-500°F. In addition, resultant strength characteristics are maintained at a steady peak level." The finished vacuum formed Lustrex liners also pass the "slam door test"—an over-loaded door slammed shut thousands of times to simulate years of actual use. Performance like this cuts rejects at the assembly level to a fine minimum . . . proof again of Lustrex performance and economy.

Investigate the moldability, strength and economies of Lustrex Hi-Test 88B for your next difficult requirement. Write for complete technical data to Monsanto Chemical Company, Plastics Division, Room 856, Springfield, Mass.

LUSTREX HI-TEST 88-B

MONSANTO

News about

B.F.Goodrich Chemical *raw materials*

PLUG VALVE *of Geon for handling corrosive fluids demonstrates molding of complicated shapes with integral threads. At the bearing surfaces Geon is molded to another plastic.*

LOOK WHAT THEY'RE MOLDING IN GEON RIGID VINYL...

All parts shown made by Tube Turns Plastics, Inc.

Geon polyvinyl chloride rigid compounds are recognized as outstanding materials for piping and fittings. Geon offers high impact and tensile strength, and superior resistance to oils, acids, alkalis, and most chemicals.

These same rigid compounds are being molded into many complicated shapes and parts in addition to piping components. Geon can be used in designs utilizing very thin sidewalls as well as heavy sections. Holes, studs, and threads can be made integrally. Parts weighing several pounds can be molded in one shot.

Despite design complexity, check Geon for strong, light, corrosion-resistant parts. For booklet on properties of rigid Geon compounds 8700A and 8750, write Dept. DX-6, B. F. Goodrich Chemical Company, 3135 Euclid Avenue, Cleveland 15, Ohio. Cable address: Goodchemco. In Canada: Kitchener, Ont.

B.F.Goodrich Chemical Company
a division of The B.F.Goodrich Company

BIG FELLOWS *include piping tee and motor housing, requiring heavy cross section, chemical inertness, dimensional stability. By contrast, molding for automobile dashboard has thin section, large projected area.*

ELECTRICAL PARTS *include fractional horsepower motor housing which reduces appliance weight, and hanger band for transformer with Geon molded around metal bolt. Geon has excellent dielectric properties.*

AUTO HORN *trumpet shows complicated contours possible in rigid Geon. Note very thin walls obtained in this high-impact material. Photos courtesy Tube Turns Plastics, Inc., Louisville, Ky.*

B.F.Goodrich GEON polyvinyl materials • HYCAR American rubber and latex • GOOD-RITE chemicals and plasticizers • HARMON colors

For Premium Vinyls

WHEN QUALITY COUNTS...COUNT ON HERCOFLEX 150

TELEPHONE COIL WIRES must have "just right" spring, low-temperature flexibility, and other premium properties. For such quality uses, Hercoflex 150 has a proven record as an ideal plasticizer for the outer plastic coating.

Indoors or out, hot or cold—wherever quality vinyl plastics are needed, Hercoflex 150 is tailor-made to provide premium properties that mean longer lasting products.

But no one plasticizer can meet all the requirements of vinyl processors. That's why Hercoflex 150 is just one of Hercules' family of Hercoflex plasticizers. Whatever you seek in a plasticizer, one member of this versatile group is sure to meet your specific requirements with "custom-made" precision.

If your files are not fully up-to-date on the Hercules plasticizers, write for the latest information. Or—if you have a specific problem, tell us your requirements, and we'll suggest the best answer based on our own experience.

HERCOFLEX®
VINYL PLASTICIZERS

Synthetics Department
HERCULES POWDER COMPANY
INCORPORATED
958 Market St., Wilmington 99, Del.

SH56-3

AUTOMOBILE UPHOLSTERY which must meet the challenge of wide temperature ranges is another application where the outstanding characteristics of Hercoflex 150 insure dependable vinyl performance.

Now and in the years to come, more and more products will become possible and practical with Styrex 767.

STYREX 767 opens new horizons for the plastics industry...*here's how–*

Here's real news! Styrex® 767, with superior crazing resistance, lends itself to applications previously considered impossible with thermoplastic materials. Plans heretofore unworkable can now be dusted off and brought to reality!

There are many reasons designers will want to start working with Styrex 767 right away–

An improved copolymer of styrene acrylonitrile, Styrex 767 is a rigid thermoplastic that is readily molded or extruded. It also has an excellent balance of physical properties. A high degree of toughness and heat resistance are combined with superb stress strength. It is resistant to acids, bases, salts, oils, waxes, soaps, food stains, and many solvents including gasoline and kerosene. Styrex 767 can be readily machined and decorative coatings are practical. It is available in natural color as well as transparent and opaque. Styrex 767 provides a new high standard of transparency in sparkling clear-toned colors. And Styrex 767 is already in full scale production, assuring availability of the product when you want it.

No matter what plastics you are using, you'll want to test this important contribution to the advancement of the industry–

Styrex 767 is the first of a family of new Dow plastics based on styrene acrylonitrile. Phone, wire or write for complete technical and application information. You'll find means to enlarge your markets, extend your fields of operation.

Dow Technical Service, with its extensive experience, is ready to help you. THE DOW CHEMICAL COMPANY, Midland, Michigan—Plastics Sales Department PL 430E.

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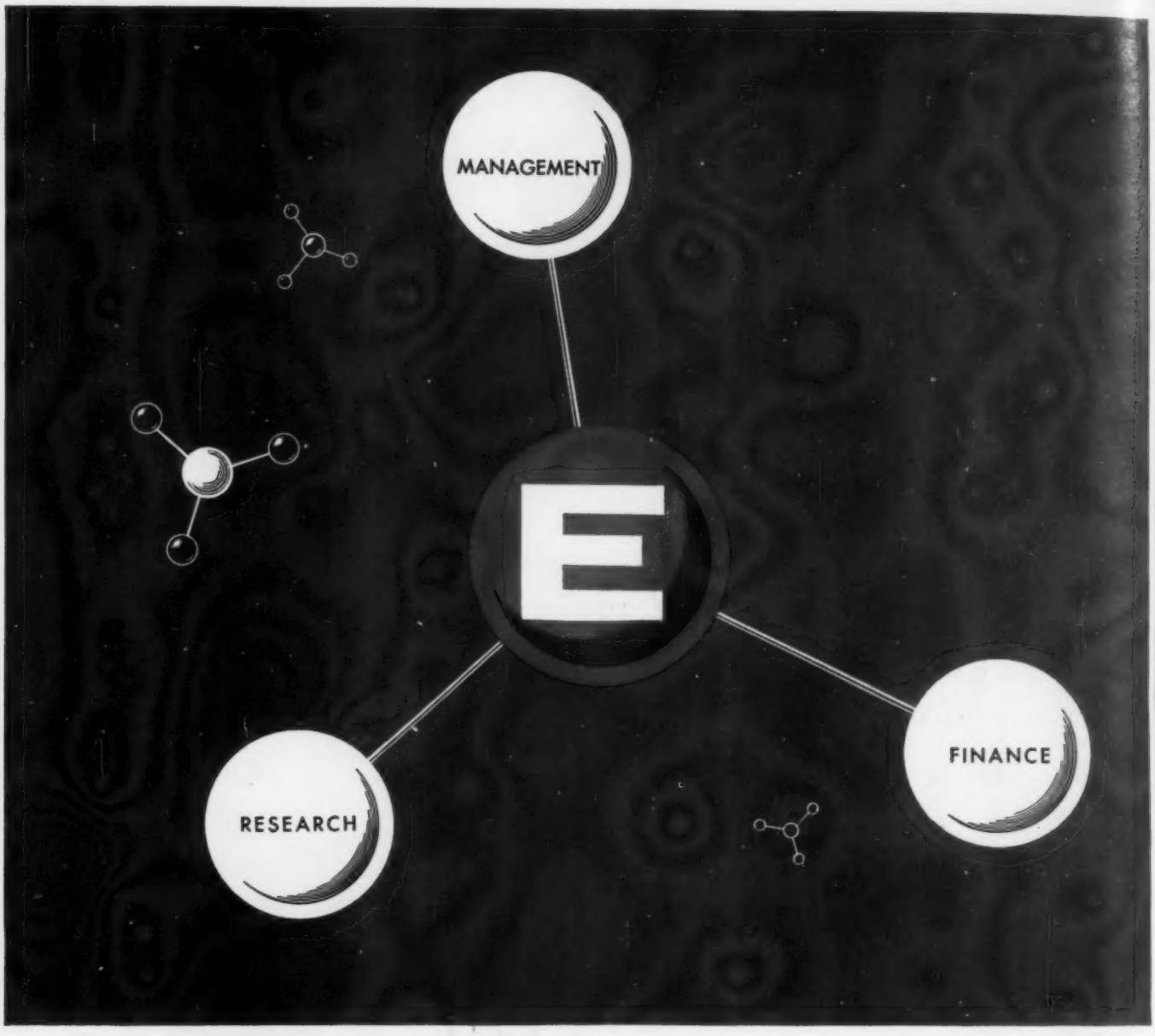

Is your problem COLOR DRIFT?

Improved Heat Stability with its advantages in quality control and processing will be offered by Escambia's general purpose, easy processing polyvinyl chloride resins.

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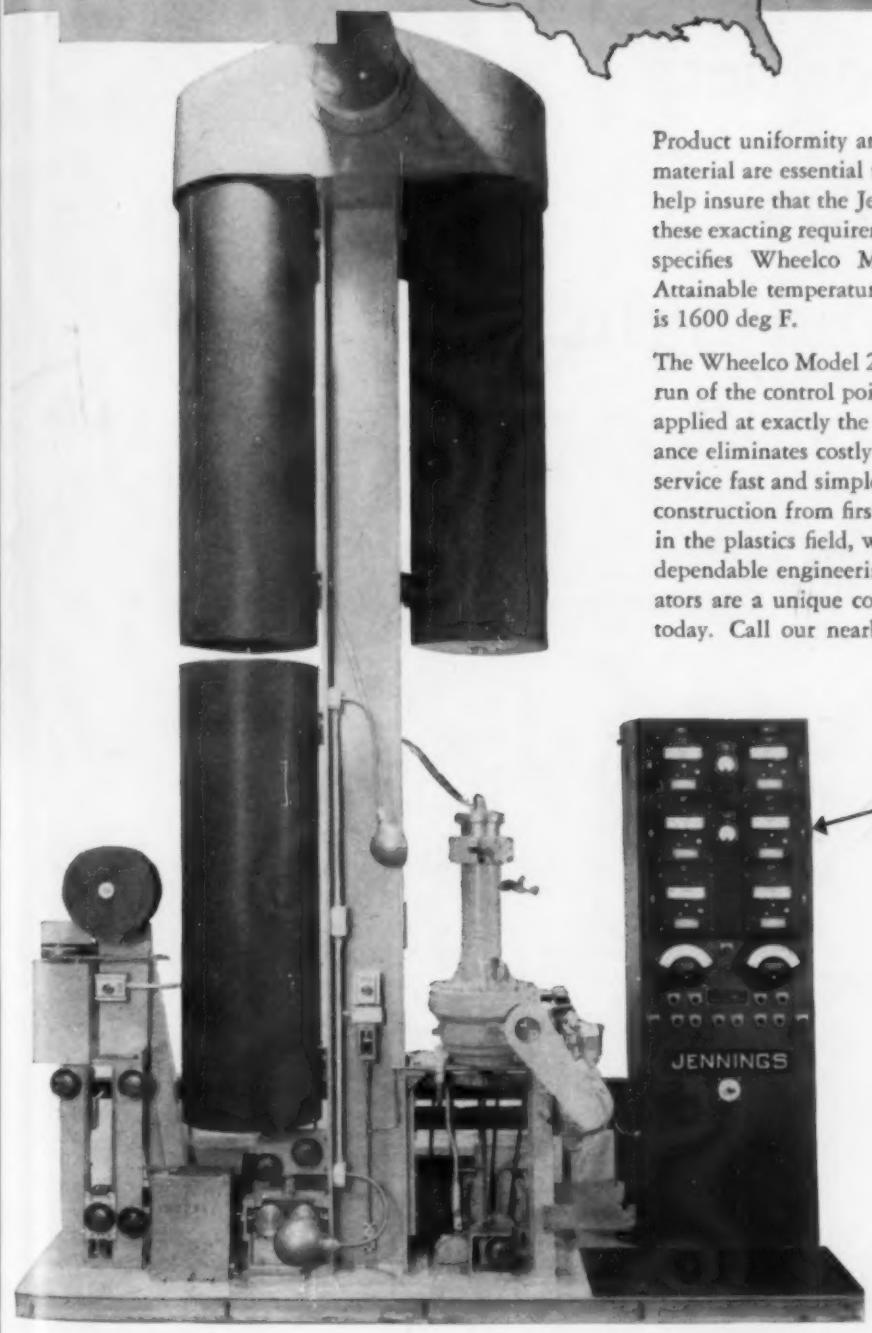
Injection, extrusion, and vacuum forming equipment manufacturers and machine users throughout the country have expressed their preference for Wheelco in the only way that counts—orders and repeat orders. Wherever temperature control instruments are used, you'll find Wheelco!



Product uniformity and continuous operation without waste of raw material are essential to profits in applying paste Teflon to wire. To help insure that the Jennings Teflon Wire Insulator Extruder fulfills these exacting requirements, Jennings Machine Corp. of Philadelphia specifies Wheelco Model 293 Capacitrol temperature controls. Attainable temperature in the sinter zone of the Jennings extruder is 1600 deg F.

The Wheelco Model 293 Capacitrol eliminates overshoot and underrun of the control point, making certain that every inch of Teflon is applied at exactly the same high temperature. Dependable performance eliminates costly shutdowns. Plug-in, easy-access design makes service fast and simple. Maintenance is minimized by sturdy, simple construction from first-quality materials. Wheelco's long experience in the plastics field, wide variety of job-specialized controls, expert, dependable engineering service, and free training schools for operators are a unique combination of advantages for you. Investigate today. Call our nearby field engineer about any plastics problem.

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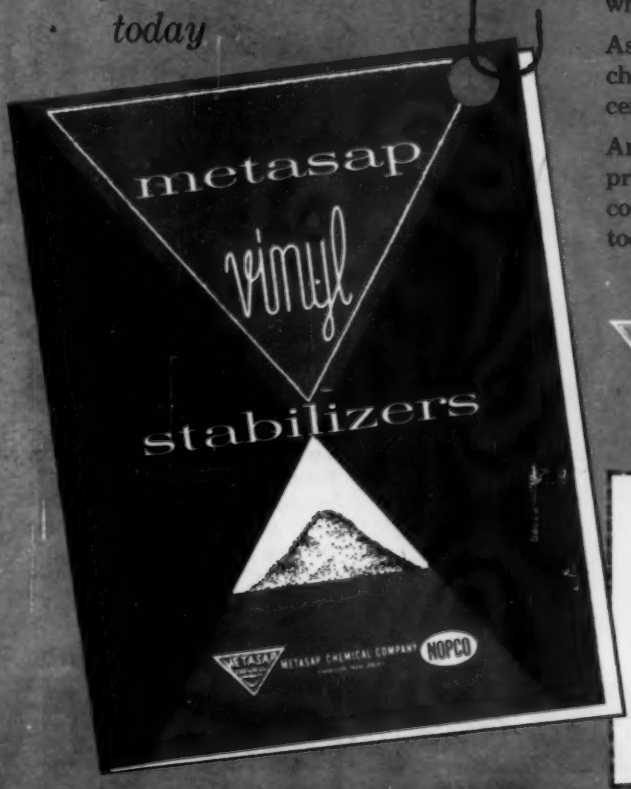

The *complete* line of Metasap Vinyl Stabilizers fully described in this new booklet are the definitive answer of the Metasap chemists to the several damaging deteriorations often found in vinyl products when exposed to heat and light.

As always, you will find that these chemists have devoted themselves to one of your central problems.

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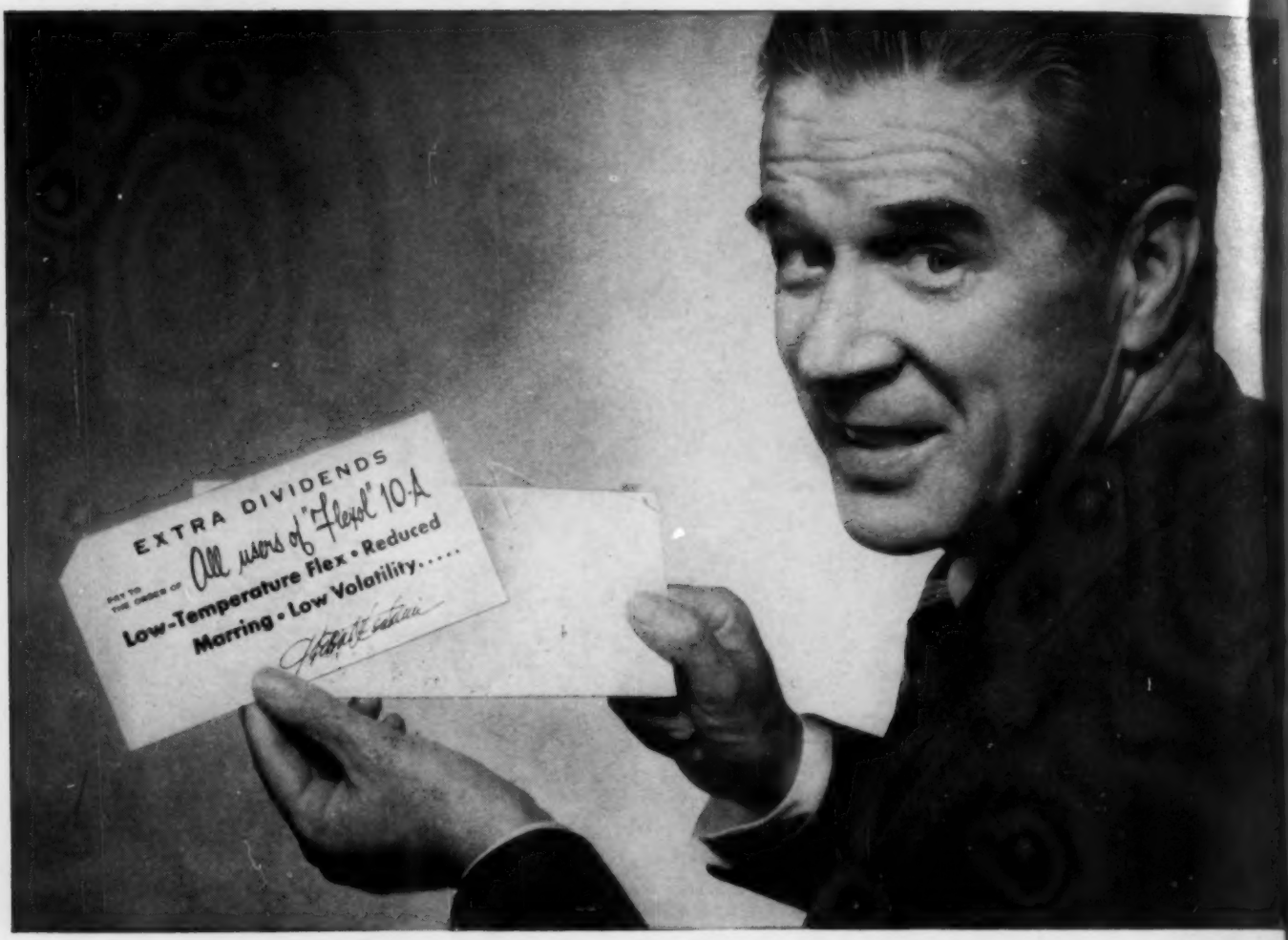

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